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PSYCHE

VOL. XXXVI DECEMBER, 1929 No. 4

OBSERVATIONS ON THE BIOLOGY OF TWO REMARKABLE CIXIID PLANT-HOPPERS (HOMOPTERA) FROM CUBA.[1]

By J. G. Myers,

Imperial Bureau of Entomology.

Our knowledge of the biology of those families of Auchenorrhynchous Homoptera which reach their greatest development in the Tropics is scanty in the extreme. This is especially the case with the Cixiidae, the intermediate stages of which are passed underground. There are not half a dozen species of these small but very interesting plant-hoppers of which the life-history is known.

The two species considered here present highly remarkable features, the one, *Mnemosyne cubana,* for its association with Ponerine ants, and for peculiar features in its metamorphosis, and the other, *Bothriocera signoreti* from its fossorial habits and modified front legs in the nymph.

These notes, which are by no means complete, were made during the tenure of an Atkins Research Fellowship at the Harvard Tropical Laboratory in Cuba. They constitute the seventh paper on the Hemiptera studied at Soledad. For acknowledgments see the first of the series *(Contr. Harvard Inst. Trop. Biol. and Med. III:* pp. 63-110, 1926).

[1]Studies from the Harvard Biological Laboratory and Botanic Garden in Cuba (Atkins Foundation).

Mnemosyne cubana Stal 1866.

Myers, *Harv. Biol. Lab.* and *Bot. Gdn. Cuba. Studies on Cuban Insects 1.*, p. 15, 1928.

I saw no specimens of this, the largest of Cuban Cixiidae, at Soledad, during February, March and most of April, but Mr. R. M. Grey took eighteen specimens (3 males and 15 females) on the 27th and 28th of April, just after my departure.

The nymphs were discovered by Dr. George Salt while we were collecting together near the Mina Carlota, in the Trinidad Mountains of Cuba, on 23rd March. He has kindly allowed me to quote his detailed notes extensively, as follows:

"A rotten tree stump about 3 feet high on the west side of a gully running south of the mine, revealed several large brown and black ants *(Odontomachus haematoda insularis pallens* Wheeler) when split open by Myers. The ants are able to inflict a most painful sting, grasping the skin with the jaws and then doubling the abdomen underneath to plunge the sting rapidly in several places within its reach.

"The ants were traced down in the trunk and below the surface of the ground, a few immature stages being found. A small colony of a tiny brown ant was found apparently entirely enclosed in the larger ant's colony and later another of these small colonies of only 2" diam., in a large chamber surrounded by galleries of the larger ant. This later colony taken.

"Two patches of white silky material were noticed among the galleries but as parts of them were composed of short radiating wheel-like threads, it was thought to be a fungus. In one, however, was found a Fulgoroid nymph which crept out of this white chamber and which I attempted to catch. It was protected by three ants, which, when the nymph was lifted, grasped it in their mandibles and were themselves carried up by it. Later others were found of various instars, from the 2nd to the 5th; many having a whorl of radiating short white silky threads attached to the tip of the abdomen.

(These "tails" were often larger than insect itself). They were always in or near the silk material first noticed. A number were found arranged in a linear series along a root of about 3/16″ diameter; the root for a length of 4″ being covered with their silk masses. The arrangement seemed to be perfect that the older nymphs were at that end of the root lower in the soil and towards the ant nest—the younger nearer to the surface of the ground and farther from the nest. Ants well in attendance and in two places of this series a large drop of clear yellowish fluid, sweet to the taste, was found. This particular root was about 3 inches below the surface of the soil running almost horizontal but a little higher towards the hill. Most of the nymphs found were thus situated, under the ground, but two chambers were found in a cavity in the rotten stump at about the surface of the ground but covered with trash of dead leaves etc., and in the dirt and debris of very rotton wood. Roots of a small vine twining around the stump passed close to the chambers.

"That the ants attended the nymphs is without doubt. Not a single nymph of about 30 was out of the company of ants, and one found under a bit of rotton log about 3′ away as well as one found through on the other side of the stump had ants in attendance.

"Nymphs ——— were active when disturbed and could jump quite well."

In the same nest was a tiny but advanced nymph of another species of Cixiid (?) with no signs of a flocculent tail-appendage.

The next day another nest of the same ant species was found *under* a log in the same general locality. We exposed a gallery along a root ¼-½ inch thick and exuding a milky juice when cut. In this gallery were numerous nymphs of *Mnemosyne* and several more of the much smaller Cixiid (?). When the ants were disturbed by the digging they became very much entangled in the flocculent material secreted by the plant-hopper nymphs. In the same gallery

were also a wood-louse, a cockroach and specimens of the curious scale-insect, *Mixorthezia sp.*[1]

This is one of the few known cases of Ponerines attending Homoptera.

A number of the *Mnemosyne* nymphs were preserved in alcohol for description later, while live ones were provided with decayed wood, rootlets and nest-material, but no ants; and an attempt was made to rear them. This was successful only with some of the older nymphs; but the exigencies of travelling made the test an unfair one. From these nymphs the first adult—a female—emerged on the 14th April. A second female appeared on the 18th and a third in the early morning of the 19th. The only male came out on the 20th. One female survived in captivity until the 25th and was then preserved for the journey north.

Professor S. C. Bruner, since my return to England, sent me nymphs of apparently the same species, attended by the same ant, at the roots of sugar-cane,—a very different habitat from that in which we found them.

Description of the nymphs:

Neither the eggs nor the younger nymphs were found, nor could adults be induced to lay in captivity.

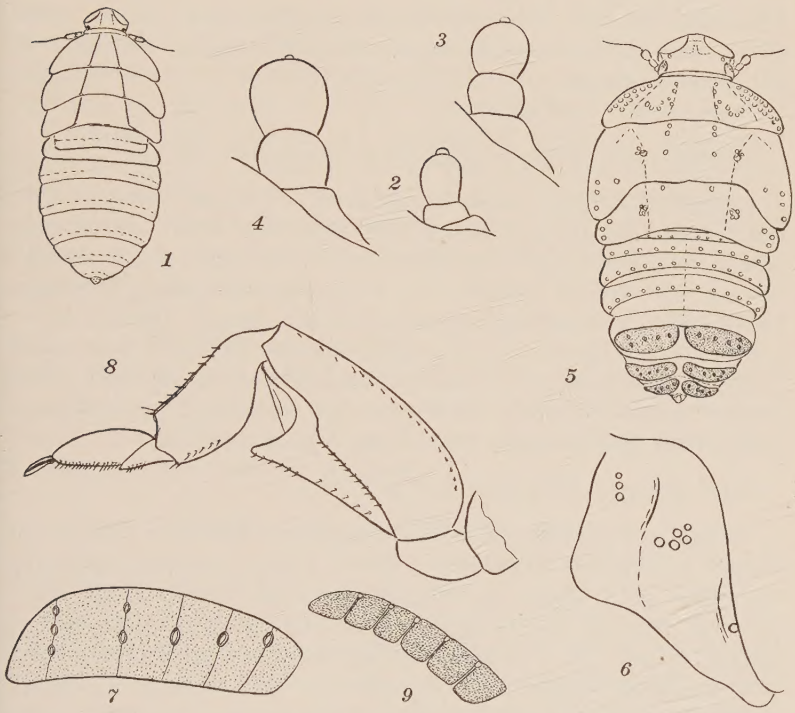
In the preserved material on which the descriptions are based, it was found that in the same instar, some had longer abdomens than others, apparently according to the time since they had moulted. The total lengths given below have been measured all on specimens with long abdomens, —thus near the end of stadium concerned.

Antepenultimate nymph: (Figure 1, outline only).

Length, 4.3 mm. Colour white, the more strongly "chitinised" dorsal sclerites of thorax and of abdomen faintly

[1]This Coccid was taken in or near the nests of the following three other species of ants (kindly determined by Dr. Wheeler), *Brachymyrmex heeri obscurior* Forel, *Euponera* (*Trachymesopus*) *stigma* F. and *Camponotus santosi* Forel; and in that of Termite, *Anoplotermes* sp. (kindly determined by Dr. T. E. Snyder).

No ants were seen attending these Coccids nor was there any indication that the association was anything but accidental.



1. *Mnemosyne cubana.* Antepenultimate nymph.
2. *Mnemosyne* antenna of antepenultimate nymph.
3. *Mnemosyne* antenna penultimate nymph.
4. *Mnemosyne* antenna last nymph.
5. *Mnemosyne* penultimate inster nymph.
6. *Mnemosyne* right hind-wing pad of last instar nymph.
7. *Mnemosyne* first left wax-plate of last instar nymph.
8. *Bothriocera signoreti,* last instar nymph, outer view of first left leg.
9. *Bothriocera signoreti* first left wax-plate.

yellowish. Eye-spots pink. Several large sensoria on head, thoracic nota and the 1st-6th abdominal tergites. A pair of large dorsal wax-plates on segments VI-VIII inclusive (strictly, on the intersegmental membranes). First wax-plate with three pores, in a row parallel to the long axis of the plate. Second and third plates also with 3 pores. Antennae shown in Figure 2.

Penultimate instar: (Figure 5, antennae, fig. 3.)

Length, 6.4 mm. (measurement of a long-abdomen form, but the figure represents an individual with short abdomen), white, the head and the other more strongly "chitinised" dorsal sclerites of thorax and abdomen yellowish. Sensoria more numerous and grouped as in the figure. On the wax-plates, extra pores have appeared as follows:—on first plate, 2 pores in a line parallel to long axis of body, and lateral to the original three; on the second, 3 such pores; and on the third, again two. Eyes larger and red.

Last instar: (Figures 4, 6 and 7.)

Length, 10.0 mm., colour as before, but the chitinised pieces a brighter brownish yellow. Large circular sensoria arranged as follows: 2 roughly parallel longitudinal rows on each side of disc of front, 2 or 3 on each side of disc of vertex, about 12 on expanded lateral border of pronotum, and 2 groups and a solitary one on each side of its disc; several scattered over tegminal pad, and a close row on its lateral margin; 2 groups and a solitary one on each side of disc of mesonotum; several on wing-pad (fig. 6), and two groups and a solitary one on disc of metanotum (each side); a single transverse row along every abdominal tergite at least up to and including *V;* a close row of minute ones, 6 or 7, in a yellowish "chitinised" lateral sclerite (pleural?) at the lateral border of each of the three wax-plates. Posterior edge of metathoracic pleuron edged strongly with dark red. First wax-plate (fig. 7) with 3 single pores, in a transverse row followed by two longitudinal rows, the first with 2 and the second with 3 pores, making 8 altogether; second and third wax-plates like the first. The number of pores varies somewhat, however, even on the

two sides of the same insect. The pores are connected, in a fore and aft direction, with their fellows before and behind or with the posterior and anterior edge of the plate. These lines, which are apparently fine grooves, are smooth and shining, as also are the pores themselves; but the wax-plate surface is dull dead white, due to a minute hexagonal sculpturing like that of many insect choria.

Towards the end of an instar the abdomen lengthens greatly (fig. 1.) At other times the abdomen is shortened and turned slightly upward, so that the three pairs of wax-plates occupy by far the greater part of the dorsal aspect of the abdomen, the tergites of segments I-V being squeezed considerably.

Curiously enough, while the penultimate instar hind wing-pad (fig. 5) has 3 large circular sensoria near its apex, the last instar has only one, which just misses being covered by the growing tegminal pad. The other two, which would be covered and thus presumably unable to function, have become obsolete.

Bothriocera signoreti Stal, 1864.

Myers: *loc. cit.* p. 15.

The striking, dark brown-marked adults of this species, with a curiously squarely-expanded head were swept during March, when the dry season was at its height from vegetation of various types, but nearly always in close proximity to water. Thus it occurred on flowering heads of papyrus in the Botanical Garden, on *Commelina nudiflora,* on two species of ferns growing in moist but not shaded situations, almost plentifully on pure stands of *Polygonum acre* along a nearly dry ditch and finally from a tangle of bushes, trees and lianes in a creek-bed.

The tegmina, in life, are held perfectly flat, like those of certain small moths, which these hoppers resemble also in general appearance.

Two adults were taken under stones in a nearly dry creek-bed of a patch of rocky forest near the laboratory. Here also the nymphs described below lived in a truly remarkable association. Under the same stones occurred large

cockroaches, land-crabs[1] *(Epilobocera armata* Smith), crayfish,[1] (*Cambarus cubensis consobrinus* Sauss.), Phrynids, numbers of tiny frogs *(Sminthillus limbatus* Cope) and an occasional blind snake *(Typhlops lumbricalis* (L.)

Advanced nymphs only were found during March. These were in crevices under the stones, or in depressions in the soil itself. Across these cavities stretched various rootlets, on some of which were colonies of a queer yellowish aphid, with a white abdominal fringe (kindly determined by Dr. P. W. Mason as *Prociphilus* sp.) Under adjacent stones were other aphides *(Ceratoglyphina* sp., Mason) attended by ants which I failed to catch, but there were no signs of ants near the *Bothriocera* nymphs. *Cyphomyrmex rimosus minutus* Mayr (kindly determined by Dr. Wheeler) were cultivating fungus on caterpiller faeces, in their nest under another neighbouring stone.

Usually two or three or even five of the nymphs occurred together, covered entirely by fine white flocculent material. Often they occupied a narrow crevice lined throughout with this waxy fluff. An adult was sometimes found (14th March) waiting beside its cast nymphal cuticle, in a kind of transparent cell of the same material.

Last instar nymph: (Figures 8, 9).

Length (long-abdomen stage) 4.5mm.

Dorsal surface dark unicolorous brown, with a median paler dorsal stripe, under-surface paler.

"Frons" swollen, smooth, passing without distinction in one round curve into the crown, but separated from the swollen clypeus by a sinuate groove. An irregular double row of small sensoria on extreme edge of "frons". None on clypeus. Rostrum just passing base of hind coxae. Crown with an irregular triple row of lateral sensoria, the inner two series large and circular; a single row of small ones continued nearly all round posterior margin. First and second segments of antennae short and very stout, the second greatly swollen. Eyes small, sunken between antenna and edge of crown.

[1]Kindly determined by Dr. T. Barbour.

Pronotum with small, roughly circular sensoria as follows:—a double row (4-4) on disc, bordering median pale stripe, a single row on outer side of fore-border, continued as a triple row along lateral border; a sinuate group of six near posterior lateral border. Some of the larger sensoria have each a very tiny one contiguous.

Mesonotum with one sensorium anteriorly, on each side of median line, a diagonal row of five, graduated in size, outside this, and a number of scattered groups on the tegmen-pad.

Metanotum with one sensorium anteriorly on each side of median line, a diagonal row of three outside this; and one sensorium on the hind-wing pad just before it is covered by tegmen-pad. (There are none on the hind-wing pad below the tegmen.)

Abdomen in the specimens described long and distended preparatory to ecdysis, but normally with part of IV and all of VII and VIII segments partially retraced and turned more or less upwards as in *Mnemosyne*. IIIrd tergite with one sensorium on each side of disc; IV with a row along posterior margin, except medially, becoming double laterally; V is similarly supplied, but the posterior edge of VI has none, save at the extreme lateral margin where there is a small group of 4, close together. The VIth tergite is rather shorter and is followed by the first wax-plate, as in *Mnemosyne* the second and third following the still shorter tergites, VII and VIII respectively. VII and VIII bear only two or three sensoria, just beneath the extreme lateral margin (i. e. occupying a ventral position.)

Wax-plates of first pair with 5 pores, all situated along anterior border and connected with posterior border by grooves, wider proportionately than in *Mnemosyne* and dividing each wax-plate into 6 divisions (see fig. 9), roughly rectangular except the outermost, which is approximately triangular. Second and third pairs of wax-plates similar, though restricted in size by the decreasing width of their respective segments.

First pair of legs markedly fossorial (fig. 8), with quite a strong resemblance to those of a cicada nymph, especially in the swollen femur.

The only comparable structure in the Fulgoroidea is that of the first pair of legs in the North Australian Cixiid, *Cajeta singularis* Stal, of which only the adult is known. I have examined this insect (a male specimen) in the British Museum, and to me the legs in question do not look at all fossorial, but rather raptorial! The femur is swollen, with two minutely-toothed ridges beneath, between which the tibia would seem to fit. Observations on the habits of this very rare plant-hopper would be of extreme interest.

NOTES ON COCOONS AND PARASITES OF *MELISSODES OBLIQUA* AND NESTS OF *PERDITA OPUNTIAE* (HYMENOPTERA-APOIDEA)

By Clarence P. Custer

Melissodes obliqua Say

I have recently described the nests of *Melissodes obliqua* Say in The Canadian Entomologist.[1] Since then I have bred 102 cocoons, obtained from the nests of the species, with the following results:

Of the 102 cocoons, 72 contained larvæ of the host and 30, those of the parasites, revealing a parasitic ratio of approximately 30%,—or about one parasite to every two hosts. Of the 72 hosts, 48 were male and 24 were females, the males reaching maturity somewhat earlier and in larger numbers than the females. This gives a sex ratio of two to one in favor of the males. Of the thirty parasites, all died except one, *Triepeolus concavus* Cresson, which reached maturity after 10 months incubation (August to June).

Since there is no fundamental difference between the cocoon containing the host and that containing the parasite, one can conclude that this Triepeoline Bee is carnivorous.[2] For in order to develop in the cocoon of the host the parasite must have postponed its feast until the pollen and honey were consumed and the cocoon spun. It is interesting to note that the parasitic larvæ possess two rows of dorsal

[1] On the Nesting Habits of Melissodes Latr. (Hymenop.). Canadian Entom., vol. 60, p. 28, 2 figs. (1928).

[2] Reinhard, in a recent publication on wasps, states that the cocoon of the parasite, *Nysson hoplisivora,* is indistinguishable from that of its host, *Hoplisus costalis,* except for its slightly smaller size. If his observations are correct, my conclusions must be regarded with reservations. Only time can reveal the answer. The problems of parasitism have, to say the least, wide fields for future study.

tubercles which are more highly developed than in the case of the host.

The average cocoon is 15 x 7.3 mm. (extremes 13 to 17 and 7 to 7.5 respectively); shape cylindrical, the ends symmetrically rounded; color dark brown; upper end covered by cap of excrement 3 mm in thickness; below this, four or five closely related, thin, shining, light amber-colored membranes of a circular shape moderately interwoven with brown fibrils; below this, the domeshaped roof of the cocoon, dark amber-colored, more abundantly supplied with fibrils and presenting a dull finish internally; wall of cocoon composed of three layers from without inward as follows: (1) Thin dull brownish membrane closely adherent to clay wall of cell; (2) Thick dull brownish membrane; (3) Very thin, glistening, light amber-colored membrane sparsely supplied with interlacing fibrils.

In the first paper, I remarked that there were large numbers of parasites flying about and entering the nests of *Melissodes obliqua* Say. The parasitic ratio of 30%, as shown by the incubation of the cocoons, tends to bear this out. However, in view of the fact that 29 of the 30 parasitic larvae failed to reach maturity (possibly due to my transferring them from an incubator at 28° C. to room temperature) I have no doubt that there are other species of *Triepeolus* besides *concavus*, which are parasitic on this bee. It is such a set of mortality statistics which so often brings our experiments in the incubation of the larvæ of wild bees to an unfortunate conclusion.

Perdita opuntiæ Cockerell

In my paper in Psyche,[1] concerning the nests of *Perdita opuntiæ*, it appears that there is room for some misunderstanding as to whether the bee actually nests in firm stone or makes use of various cracks and faults in which to construct its tunnelways. Mr. S. A. Rohwer, of the United States Department of Agriculture, in particular has called

[1]The Bee That Works in Stone; *Perdita opuntiæ* Ckll. Psyche, vol. 35, No. 2, pp. 67-84. (1928).

my attention to the fact and states that the paper gives "the impression that the bee would not be able to live within the stone if it were not for some crack or fault on its surface".

No doubt the misinterpretation arose from Fig. 1 which represented a typical nest, all of the tunnelways being in the same plane. The entrances to this particular nest *were* in a crack. I had chosen it for the illustration because I could show all the ramifications of the tunnelways in two dimensions. In this respect it was not a typical nest.

The actual condition is this: Dozens of nests of *Perdita opuntiæ* are found in the firm stone at White Rocks, Colorado. Each nest has two or more entrances. In a small percent. of the nests the entrances are found in cracks or faults in the stone. *But in the majority of the nests the entrances are situated in solid stone in the immediate vicinity of which there is not the slightest sign of a crack or fault.* In these latter nests one finds the entrances irregularly distributed over the surface of the stone in such a manner that they could not be connected together by a crack. Also upon excavating these nests one finds that the tunnelways are not confined to individual planes (as would be the case if they were in faults) but ramify in all three dimensions throughout the stone. So there is no doubt that the bee actually nests in solid stone.

I might mention in passing that in the original paper, page 75, I stated that I had found no report in the literature of a wasp digging its nest in stone. Since then I have learned from Dr. Davidson, in California, that years ago he had published a paper describing the habits of a wasp that nested in a soft sandstone.

DESCRIPTIONS OF FOUR NEW FORMS OF ERIOPHYES.[1]

By James Kendall

Bussey Institution, Harvard University.

Preliminary to a study of four Eriophyid galls occurring very commonly in Massachusetts, New York, and New Jersey, it was necessary to determine the taxonomic position of the causative parasites. As a result of examinations of many specimens from each gall collected over a period of several months these mites were determined to be new forms of *Eriophyes* and a detailed description was made to indicate the relationship of each of these forms. Comparisons with already known and described species are given in the case of each mite hereafter described, together with a figure showing the more characteristic distinguishing features.

The material from which the present data were taken was collected primarily in the Arnold Arboretum, Forest Hills, Mass.; additional material was collected from southern New York and northern New Jersey. The mites and the host or hosts with which each is associated are as follows: *Eriophyes celtis,* sp. n. on *Celtis occidentalis* L. and *Celtis occidentalis canina; Eriophyes rudis dissimilis,* subsp. n. on *Betula lutea* Michx. f.; *Eriophyes eucricotes multistriatus,* var. n. on *Lycium halimifolium* Mill.; and *Eriophyes fraxinivorus americanus,* var. n. on *Fraxinus americana* L.

The taxonomy of the Eriophyidæ has been and still is a problem. The rules for the systematic separation of the forms have been given in some detail by Nalepa (1924) but have been the source of disagreement between himself and Cotte (1925). Part of the trouble hinges on the question of the importance of physiological differences. What status

[1]Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 325.

shall be given to a form that is similar to another but is limited to a different host species? Shall we regard it as a variety, a species, or what?

The discussion of varieties Nalepa brushes aside with the remark: "Für den prakticken Cecidologen ist die Kenntniss der Varietäten der Arten and Unterarten bedeutungslos." According to his dictum one must distinguish between the fluctuating variations of a species within itself and the constant variations in a biological sense. Then: "Als Varietäten werden wir grundsätzlich nur jene Variationen des Arttypus bezeichnen, die das gleiche Cecidium auf verschiedenen, jedoch verwandten Wirtspflanzenarten verursachen." And ". . . erzeugen die Subspecies verschiedene Gallenformen auf ihrer gemeinsamen Wirtpflanze."

Cotte protests that much of Nalepa's work is useless and that a system of taxonomy can be acceptable only if fixed by common consent, not by one person. He condemns the subjugation of morphological to biological characters practiced by Nalepa, a new host is not sufficient evidence to establish a new variety. The objections of Cotte are justified provided Nalepa's rule is followed without any further confirming data. If distinct morphological characters are not forthcoming to distinguish the form in question, then controlled observations on the physiological limitation of this form to a certain host plant are necessary to justify establishing it as a variety or subspecies of another similar or even identical morphological form on a closely related species of host.

Where it has not been possible to control the infestation and so determine whether the mite forming an identical or similar gall is limited to the specific host and where the morphology of the mite itself is relatively close to a known species, but still different, after allowing for the variations within the species, I have considered it to be a variety of the species already described from a similar gall on a plant of the same host family. This is the case with the two new varieties presented in this paper. In the case of the one new subspecies, *E. rudis dissimilis,* the separation is based on differences of morphology in the mite and the gall form with which it is associated as well as its limitation to the

single host. It was possible in the case of *E. celtis* to check the limitation of the mite to the specific host and find that it was not adaptable to the host which is affected by what would appear to be morphologically a closely related form.

For a key to the genera of the family and the features used in classification one is referred to the work of Nalepa or of Hassan.

Technique

The importance of reliable permanent preparations and the fact that the methods for making permanent collections have long been unsuccessfully sought justifies giving some attention to the methods and media used when new members of the various genera or species are described. It is very easy to obtain great numbers of these mites by drying a quantity of galls in open vials ringed inside at the top with glycerine to prevent the mites escaping. If these vials are then placed in a desicator out of any strong light or heat most of the mites will leave the galls in a few hours and will be found wandering about the sides of the vials (s. Nalepa, 1906 and Hassan, 1928). The question then arises how they can be kept permanently and studied at any time under the microscope. Various media have been tried and found quite useless for anything more than immediate study. In all these media (glycerine, glycerine and acetic acid, glycerine jelly, balsam, euparal, gum arabic solutions, water, alcohol, etc.), the mites are more or less distorted and shrunken or become almost transparent, so that in a short time the mounts are useless and new specimens are needed. Until recently, it was necessary to use alcohol for permanent collections and make new mounts from this material each time one desired to study the mites in question. The alcoholic material becomes hardened and breaks so easily that the specimens are useless for taxonomic work a few years after collection. Other media have the same or additional drawbacks. Apart from the temporary nature of these collections there are the factors of distortion and shrinkage to be considered, as well as the improbability of being able to re-examine the same specimens at any time.

Recently, Hassan (1928) developed a method for making permanent mounts of the Eriophyidæ by modifying a

method for manipulating small organisms. The mites are killed and cleared by heating them in a 10% solution of potassium hydroxide that is poured over them in the collecting vials after the plant tissues have been carefully removed. This solution containing the cleared mites is poured through a short piece of small glass tubing having at one end a guncotton plug in which the mites are caught as the solution passes through. The mites and the plug are then washed thoroughly with distilled water before the alcohols of various grades are passed through the tube to dehydrate and harden the specimens. After treating with absolute alcohol the guncotton plug is removed together with the entangled specimens from the tube and placed in a vial containing a solution of absolute alcohol and ether in equal proportions by volume. In this solution the guncotton dissolves and the mites settle to the bottom of the resulting weak solution of celloidin thus formed. A drop or two of this solution and great numbers of the mites can be easily removed by a pipette to a slide smeared with albumen fixative; the alcohol and ether evaporate rapidly leaving the mites embedded in a thin layer of celloidin. After reaching this stage the slides can be kept indefinitely before proceeding or they can be colored immediately in acid fuchsin, dehydrated, and cleared in carbol-xylol before sealing on a cover glass with balsam or euparal. This method has two disadvantages that necessitate careful checking of the specimens thus mounted and those freshly mounted in other media. The first of these results from the destruction of the body contents by the use of potassium hydroxide solution, thus removing the most reliable indicator of the maturity of the females, that is, the content of eggs within their bodies. Since the classification is based primarily on the mature females it is important that only mature individuals should be used when making measurements for descriptive purposes. Secondly, there is a disadvantage in the position the specimens assume when mounted by this method; the setæ and any slight curvature of the body become fixed during the hardening process and cause the specimens to roll upon their sides when transferred to the slides. The lateral aspect thus presented in these mounts makes it dif-

ficult, if not impossible at times, to determine the dorsal and ventral characters accurately.

An easier and quicker method that gives better temporary mounts for studying the specimens to be described and for checking the characters of specimens mounted in celloidin, is the iron-acetocarmine method of Belling (1926), which is used widely in cytology for studying pollen mother cells. Large numbers of mites and their eggs can be dislodged by dipping small pieces of the galls into a drop or two of this stain placed in the center of a slide. This must be done rapidly and a cover glass placed on immediately to prevent evaporation of the stain. The mites are fixed without distortion and only sufficient of the stain enters the body, unless the mite has been crushed during removal from the gall to the slide, to make the contents distinguishable. If the cover glasses are sealed on by several applications of gold size, euparal, or balsam, it is possible to keep such mounts a reasonably long period. They have the advantage of being very thin and specimens are spread out to display the ventral and dorsal aspects in most cases, rather than the lateral aspects presented in the celloidin mounts. The darker background of the stain together with the slight internal staining of the body makes it easier to distinguish many of the morphological characters. Neutral red may be used with much the same result as the acetocarmine. The advantages of these mounts are counterbalanced by their fragility and probable lack of permanence, though specimens mounted in this manner have been kept for a year in a state of good preservation.

Eriophyes celtis, sp. n.

Hosts: *Celtis occidentalis* L., *Celtis occidentalis canina.*

In 1903 Di Corti described a mite, *Eriophyes bezzii*, from specimens found in colonies in deformed buds of *Celtis australis* L. The gall resulting from the parasitism of these mites is limited, according to his descriptions, to the arresting of the buds and their subsequent swelling. In the northeastern United States there is a common gall consisting of a bud deformation associated with a witch's broom develop-

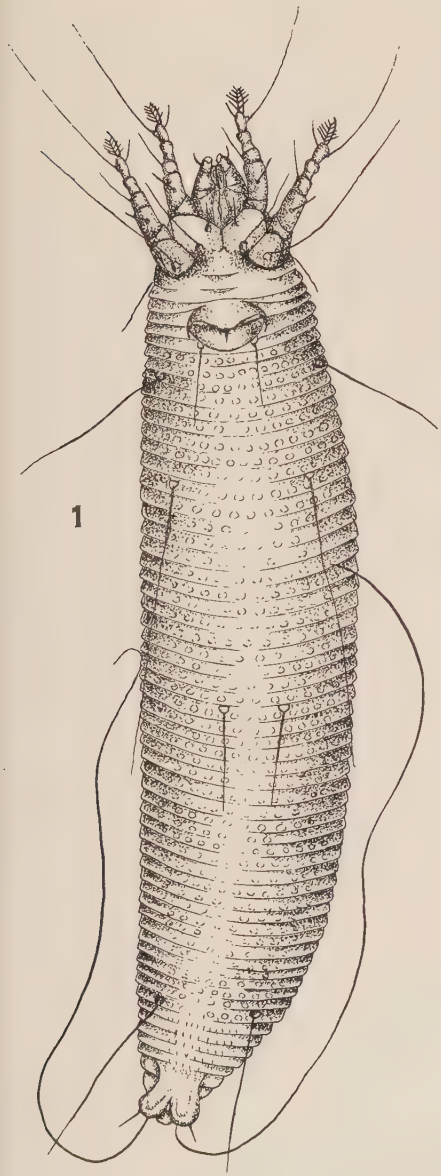
ment, that has been reported many times on *Celtis*. It has been attributed to the work of mites by some reporters and to the work of a fungus by others. No mites have ever been described from the gall though they were observed to be present in the buds. Kellerman and Swingle (1888) first observed this gall on the hackberry and attributed it to the activity of a fungus, which they described as *Sphærotheca phytoptiphila*, associated with a species of gall mite. Reuter, in 1903, cited it as an interesting case of coparasitism on the basis of their investigations, while Cook (1904), Chadwick (1907), and Felt (1917) considered the mites alone responsible but did not study the gall or mites. In examinations of these galls I have always found an abundance of the mite, *E. celtis*, and usually the mycelia of a fungus as well in the swollen buds where the gall formation has its origin. Only experimentation will be able to decide as to the part played by each of the factors present in these galls. It seems very likely that the mites are mainly responsible, since the fungus, if it is the one described by Kellerman and Swingle, belongs to a group not associated with witch's broom formations.

The morphological characters of the mites found in these deformed buds of *C. occidentalis* differ quite distinctly from those of *bezzii* described by Di Corti. The body size is nearly twice as large, although part of this difference may be attributed to the shrinkage of Di Corti's specimens which were preserved in alcohol. The shield has a clear design of ridges and is more nearly semi-circular than semi-elliptical; the sternal ridge is bifurcate, not simple; and the setæ are all much longer and have different relative lengths. The accessory setæ are present, not lacking as in *bezzii*. Figure 1 illustrates the characters that are given in the following description of *celtis*.

The cylindrical body of the mature female is more than four times as long as broad, about 270 microns in length and 60 microns in width. The thoracic shield is semicircular with three distinct ridges usually in the center field projecting above the plane of the shield and giving it a jagged anterior border; in the side field a ridge curves back from

the region of the anterior border of the shield to the region above the setal tubercles near the posterior border. The dorsal setæ (c. 34 microns) arise from the prominent tubercles at the posterior border of the shield. The legs are short and comparatively stout; the tibia and tarsus are equally long (c. 6 microns) ; the feathered claw is large and five-rayed; the bristle claw of the first pair of legs is as long as the feathered claw while that of the second pair slightly overreaches it; the epimera are short; the sternal ridge is distinctly bifurcate and reaches to the level of the inner corner of the epimera. The first pair of thoracic setæ are short (c. 10 microns) and stiff, the second pair are of medium length (c. 30 microns), and the third pair are very long (c. 50 microns). The abdomen tapers slightly in the posterior fourth and ends in a small telson that bears the long flagellate caudal setæ (c. 120 microns) and the short (c. 6 microns), acicular accessory setæ. The rings of the abdomen are broad, about 60 in number, and there are numerous tubercles relatively close together on the ventrum but usually lacking on the dorsum. The last five rings are without any tubercles but have longitudinal striations ventrally. The epigynum is broad (c. 30 microns) with a smooth anterior flap and an arched, slightly keeled, posterior one. The genital setæ (c. 25 microns) are more or less posterior to the plane of the genital opening. The lateral setæ arise about three striæ posterior to the plane of the epigynum and are about the same length as the dorsal setæ (c. 34 microns). The first pair of ventral setæ are the longest (c. 75 microns), the second pair are the shortest (c. 20 microns) and the most nearly median of the ventral setæ, the third pair are about 38 microns long and comparatively coarse. Measurements of other setæ: outer setæ c. 30 microns, maxillary setæ c. 6 microns, claw bristle of the first pair of legs c. 8 microns, of the second pair of legs c. 10 microns, femoral setæ c. 12 microns.

Although it does not at any time effect a witch's broom formation, there is another factor to be considered in the deformation of the buds of the same hosts as those of *E. celtis*. This is the hemipteron, *Pachypsylla gemma* Riley, which often causes galls involving the deformation of buds



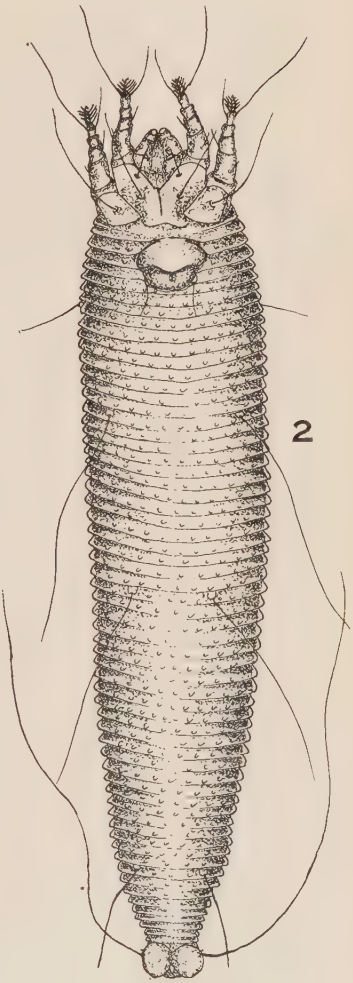


Fig. 1. Ventral view of *Eriophyes celtis* sp. n.
Fig. 2. Ventral view of *Eriophyes rudis dissimilis* subsp. n.

into woody capsules. In one case it was observed that both it and the mites had attacked the rudimentary leaves of the same bud. The close association and limitation of these two parasites to the same host and same portion of the host may possibly be used to explain the very wide distribution of the mites over the same plant and over all the host plants in the neighborhood, even when these are widely scattered. The mature mites may be disseminated by the winged *Pachypsylla* females when the latter seek out the new buds in the early spring migration. This migration period of the hemipteron coincides nicely with the requirements of the mites for favorable infestation, occurring as it does before the buds expand.

In a mixed group of species of *Celtis (C. australis, C. Bungeana, C. Douglasii, C. laevigata, C. occidentalis,* and *C. occidentalis canina)* in the Arboretum it was possible to experiment with the limitation of the mite to its host plant. To make sure that it was not because it could not reach the other species of the same genus of host plant artificial infestations were carried out. None of the other species of the host unaffected under natural conditions reacted to the mites placed in their buds, or else the mites failed to find the host suitable and did not attack it. These infestations merely substantiate the condition of limitation or specialization of a species to a single host species, a condition that appears to be very general in the Eriophyidæ.

Eriophyes rudis dissimilis subsp. n.

Host: *Betula lutea* Michx. f.

The typical species of this mite was described by Canestrini from *Betula verrucosa* Ehrh. and *Betula pubescens.* Nalepa (1898) attributed to it the formation of both the erineum of the leaves and the bud deformation of these hosts. Later, in 1919, he differentiated the form producing the bud deformation and associated with a witch's broom formation on *B. verrucosa* as a subspecies, *calycophthirus,* of the typical *rudis* found in the erineum. In their list of galls and producers Ross and Hedicke (1927) give *B. nana,*

pubescens, urticifolia, and *verrucosa* as hosts of this subspecies; it has also been considered as the cause of the bud deformations of *B. lutea.* However, the mite found in the deformed bud masses of this latter host differs distinctly from either the typical species or the subspecies described by Nalepa. It has a larger body size, more striæ, and a pair of accessory setæ setting it off from the typical species. From the subspecies mentioned it differs in the possession of the accessory setæ, larger body size, and shortened shield. The gall produced by *dissimilis* is quite different from that of the other two forms mentioned and appears to be limited to the single host from all reports and collections, as well as not being associated with a witch's broom formation. The early descriptions of the gall were made without any attempt to give the species of mite causing it. In 1909 Stebbins described the gall again from the same host and attributed it to a new species of mite, *Eriophyes betulæ,* without examining the mite and giving a description of it. Unfortunately, the name thus chosen had already been used by Nalepa to designate the species of mite producing the pouch gall on *Betula verrucosa* in middle Europe and southern Tyrol. Figure 2 represents the morphological characters of the mite whose description follows.

The body is cylindrical, tapering gently from the thoracic shield to the telson; the female measures about 240 microns in length and about 55 microns in width. The thoracic shield is semi-elliptical, clearly delimited posteriorly and rounded off anteriorly; the center field has three full length wavy ridges traversing it, the two outer ones diverge toward the posterior border of the shield; on the side there is usually an indistinct ridge from the region of the anterior border curving back about the setal tubercles near the posterior border. The dorsal setæ are coarse and about 20 microns in length. The rostrum is short, stout, and ventrally curved. The legs are relatively short; the tarsus and tibia are equally long (c. 5 microns); the claw bristle (c. 10 microns) is curved and slightly overreaches the feathered claw of the second pair of legs and equals that of the first pair; the feathered claw is large and four-rayed; the outer setæ are

long (c. 25 microns) and fine; the inner setæ are very short. The sternal ridge reaches to the region of the inner corner of the epimeron and is not forked. The first pair of thoracic setæ are short (c. 8 microns), the second are anterior to the plane of the posterior end of the sternal ridge and about 30 microns in length, the third pair are the longest (c. 45 microns). The abdominal rings, about 80 in number, have a distinct row of small, well separated tubercles along their posterior border but in the last five these are replaced by ventral longitudinal striations. The epigynum is about 20 microns in width and lies immediately posterior to the cephalothoracic region; the lower flap is hemispherical and slightly keeled; the upper is smooth and either flat or slightly arched. The genital setæ are lateral and about 12 microns in length. The lateral setæ are below the plane of the epigynum, are fine, and are about 20 microns in length. The first pair of ventral setæ are the longest, about 60 microns, the second are the most median in arrangement and about 50 microns in length, the third are the coarsest and shortest (c. 20 microns). The short, broad telson bears the long caudal setæ (c. 90 microns) and the very minute accessory setæ (c. 4 microns).

Eriophyes eucricotes multistriatus var. n.

Host: *Lycium halimifolium* Mill.

The typical form of this species was described by Nalepa in 1892 from specimens collected from pustules of the leaves of *Lycium europæum* L. and *Lycium mediterraneum* Dun. occurring in southern Europe and Algiers. The mite from *Lycium halimifolium* produces a gall very similar to that of the typical species, namely, a pustule on the leaf, but in addition attacks the young twigs, petioles, floral leaves, stamens, and ovaries of the host. Besides its apparent limitation to a different host there are constant morphological characters that distinguish *multistriatus* from the typical form: the abdominal striæ are uniformly greater in number, the tuberculation of the abdominal rings is both dorsal and ventral in distribution, is finer and more abundant, and

the stature of the mite is larger. Figure 3 illustrates most of the distinctive characters which are given in the following description of this variety.

The mature female is orange-yellow and measures about 250 microns in length and 70 microns in width, compared to 210 microns by 50 microns in the typical species. The thoracic shield is very small, triangular, and either smooth or traversed by indistinct ridges. The dorsal setæ arising from large tubercles at the posterior edge of the shield are long (c. 40 microns) and slender. The legs are relatively short and weak; the feathered claw is five-rayed, the claw bristle of the first pair of legs is shorter than that of the second but still exceeds the length of the feathered claw. The sternal ridge is not forked and does not reach quite to the line of the inner corner of the epimeron anterior to which the second pair of thoracic setæ (c. 20 microns) arise. The third pair of thoracic setæ are the longest, about 60 microns, the second pair are the shortest, as usual, and anterior to the plane of the anterior end of the sternal ridge. The rings of the abdomen are relatively narrow, about 80 in number, with abundant fine tuberculations both dorsally and ventrally—the typical form has 60 rings with widely separated tubercles. The epigynum is very small, about 16 microns broad, with an unmarked cover-flap. The lateral setæ are about as long as the dorsal ones and are approximately in the plane of the epigynum. The first pair ventral setæ are the longest (c. 65 microns); the second pair are the shortest and most median (c. 30 microns); while the third pair are relatively coarse and about as long as the dorsal setæ. This last pair of setæ reach over the telson which is comparatively small and bears the long flagellate caudal setæ (c. 120 microns) and accessory setæ that are coarse and about 7 microns in length.

This variety of mite was very convenient for carrying out experimental infestations to determine the connection between the mites and the various abnormalities observed in the plants tissues. Experiments were carried on in the greenhouse during the winter with plants grown from seeds and cuttings. Unaffected plants of *Lycium* were readily in-

fested by mites taken from old galls on the leaves of others. Beginning with a single gall the infestation spread over the young plant so rapidly that by the time it had grown several inches in height the expanding leaves had their surfaces entirely covered with the developing pustules. Young plants growing from seed in the same pot as the infested cutting showed galls on their first foliage leaves but not on the cotyledons. The spread of the infestations can readily be followed upward over the new hosts. Other species of Solanaceous plants, *Solanum capsicastrum, Nicotiana Langsdorffii, Datura Wrightii,* and *Capsicum pyramidale* were used in these experimental infestations without any positive results.

Eriophyes fraxinivorus americanus var. n.

Host: *Fraxinus americana* L.

In 1885, Karpelles described a mite, *E. fraxini,* which he found abundant in the galls commonly known as "Klunkern" occurring on ash and described by Löw in 1874. These galls were found to arise from the deformation of the floral parts of *Fraxinus excelsior* L. and *Fraxinus viridis* Bosc. into a monstrous ball-shaped mass covered with an almost colorless pubescence and resembling the upper parts of the cauliflower. In America there has been some confusion and uncertainty concerning the relationship between like masses of tissue and the gall mites. Felt (1906) reported fringed, lobulated balls of deformed staminate flowers of the white ash and considered the mite that he found in them as a new species, *E. fraxiniflora,* without describing it or comparing it with that already described by Karpelles from a similar gall in Europe. Another gall arising from the deformation of the terminal buds of the white ash where development is arrested and a mass of small twisted leaf ends replaces the normal foliage was first reported by Garman in 1882. Failing to find any mites in his specimens he considered it was probably a fungoid growth. On the basis of Felt's assurance that mites were found in the masses arising from staminate flowers this other foliose mass was also listed as resulting from mite parasitism without any search for or study of the mites themselves.

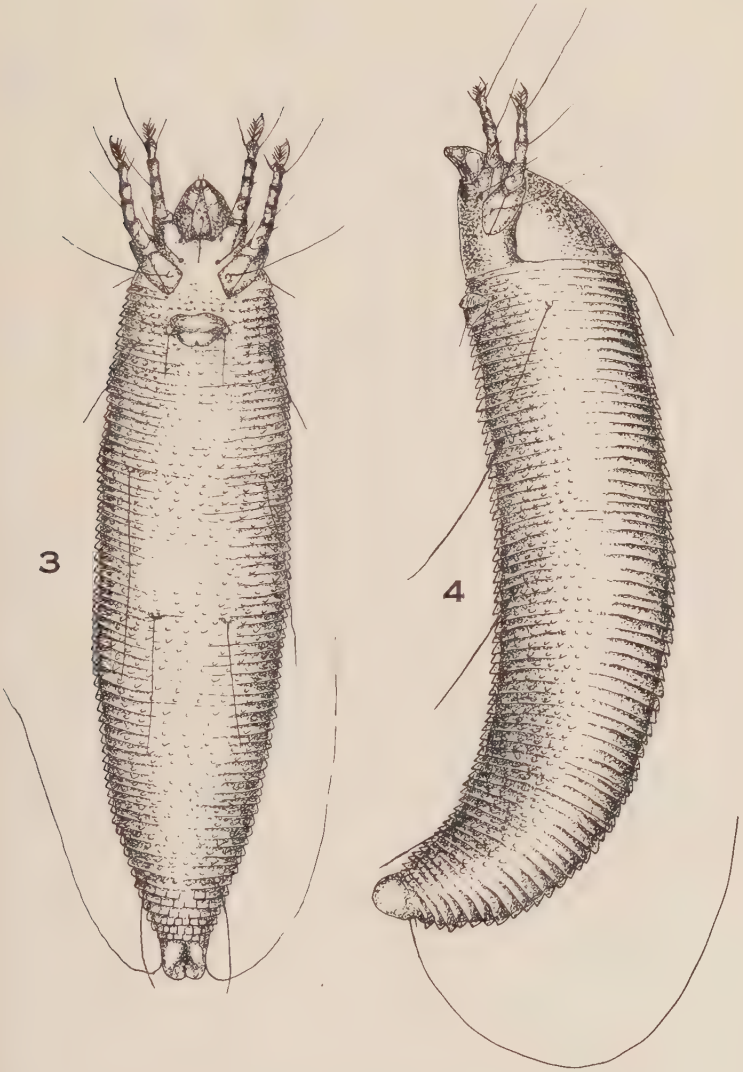


Fig. 3. Ventral view of *Eriophyes eucricotes multistriatus* var. n.

Fig. 4. Lateral view of *Eriophyes fraxinivorus americanus* var. n.

The gall of *americanus* is the one characterized by a mass of fasciated foliage tissue that Garman noted. I was not able to obtain any of the flower galls described by Felt so could not determine if the same variety of mite is responsible for the two deformations. Large numbers of mites were collected from the foliose masses and determined as a variety of the typical form first described by Karpelles as *fraxini* but known now as *fraxinivorus* Nal., since the former name had been used by Garman two years prior to Karpelles to designate the mite producing capsule galls on ash leaves. Figure 4 is a lateral view of the variety *americanus* whose description follows.

This mite is to be distinguished from the typical species, apart from the differences of host and parts involved, by the unforked sternum, greater number of striæ, differences in the relative lengths of the ventral setæ, shorter accessory setæ, and much greater body size.

The body is long, about 250 microns in length and 55 microns in width for the female, and has a small cephalothorax. The thoracic shield is semi-elliptical, smooth, or traversed by indistinct longitudinal ridges. The dorsal setæ arise near the posterior border and are about 30 microns in length. The legs are short and slender, the tarsi are longer than the tibiæ; the feathered claw is four-rayed; the bristle claw, about 10 microns, is longer than the feathered claw of either pair of legs; the patellar setæ are about 24 microns in length; the inner setæ of the tarsi are about 4 microns, the outer ones about 25 microns long. The first pair of thoracic setæ are very short and lie forward of the plane of the anterior end of the sternum; the second pair are median in length and lateral to the posterior end of the sternal ridge which is not forked; the third pair are the longest, about 40 microns. The abdomen has 75-80 rings that are tuberculated rather finely on the ventrum but with more sparsely distributed tubercles on the dorsum; the last five rings are without such tubercles and are longitudinally striated ventrally. The abdomen ends abruptly in a short telson that bears the very short accessory setæ, about 6 microns, and the caudal setæ that are about half the length

of the body. The epigynum is comparatively small with the anterior flap longitudinally striated and the posterior one slightly keeled. The lateral setæ are in the same plane as the epigynum and about 30 microns in length. The first pair of ventral setæ are the longest (c. 44 microns), the second pair are about the same length as the lateral setæ but coarser, the third pair are rather coarse and the shortest (c. 20 microns) of the three pair.

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IS NECROPHYLUS ARENARIUS ROUX THE LARVA OF *PTEROCROCE STOREYI* WITHYCOMBE

By William Morton Wheeler

Nearly a century ago, in 1833, J. L. F. P. Roux, in a letter addressed to Baron Férussac and published in the "Annales des Sciences Naturelles" mentioned and figured a remarkable insect, with the prothorax continued anteriorly into an enormously elongate and attenuate "neck," broad mesothorax, metathorax and abdomen, long, slender legs and small head with falcate mandibles. It measured nearly 11 mm. and was "found running over the sands which encumber the interior of tombs hollowed out in the rock of the environs of the pyramids of Gizeh," near Cairo, Egypt. To this insect which he believed "should necessarily constitute a new genus among the hexapod Aptera," Roux gave the name *Necrophylus arenarius* (p. 76). The editor (probably Audouin) in a foot-note asks whether it is not more probably the larva of some insect, "perhaps that of Mantispa or Raphidia." Turning to the explanation of the two illustrations (Figs. 3 and 4) on p. 78 and their legend on Pl. 7 we find in both places the name of the insect given as *Necrophilus arenarius*. This change in spelling is very probably due to the editor (Audouin), and has been followed by all the subsequent authors who have referred to the insect. The generic name thus becomes a homonym of Necrophilus (Coleopt.) Latreille (1929). But it is not improbable that Roux wished the name to signify "associated or allied with the dead," instead of "loving the dead." If this was his intention, we might have expected him to use the form "Necrophylius," but the Greeks seem occasionally to have preferred the shorter form "phylos" as in "emphylos." Be this as it may, however, our rules of nomenclature require us to return to Roux's original spelling of the

generic name, and this precludes its homonymy with Necrophilus Latreille.

In 1857 Schaum, in the first article of the first volume of the "Berliner Entomologische Zeitschrift," gave a description and excellent figures of what he regarded as Roux's insect, with an account of the alimentary canal and nervous system, drawn from some 20 specimens which he had captured in 1852 in the dust of tombs at Beni-Hassan, near Cairo. Schaum was strongly of the opinion that the insect was a larval Nemoptera. Westwood had previously reproduced Roux's figure in the second volume of his "Introduction to the Modern Classification of Insects," (1840) and had ventured the suggestion that the insect from its size might either produce a Nemoptera, Bittacus or Panorpa." Within more recent years Roux's or Schaum's figures have been reproduced in various other general accounts of the Neuroptera, such as those of Sharp, Navas and Maxwell-Lefroy.

The mystery which has so long enveloped the affinities of Necrophylus has been recently dispelled by G. Storey, entomologist of the Egyptian Ministry of Agriculture, and C. B. Williams (Eltringham 1923, Withycombe 1923-b, 1924), who found it near Cairo, in the dust accumulated on the floors of desert caves or under rocky ledges and succeeded in rearing the imago. This proves to be a Crocine Nemopterid, to which Withycombe (1923a) has given the name *Pterocroce storeyi.* Storey reared a few adults from larvæ taken about 1915 from a cave some four miles from Wadi Digla, where Williams obtained his specimens in 1922. Eltringham and Withycombe have published excellent figures of the larva, (one of which is here reproduced as Fig. 1), and the latter has also described an allied form, *Nina joppana,* males and females of which had been reared in 1921 by Aharoni (Blair 1920-1921) from larvæ taken in the sand of caves near Jaffa, Palestine. The larva of this species closely resembles that of *Pterocroce storeyi* but has a distinctly shorter "neck."

Both Eltringham and Withycombe seem to believe that the introduction of the new name *Pterocroce storeyi* is justified for the insect reared by Storey and Williams. Eltring-

ham offers the following comment on Roux's drawing of *Necrophylus arenarius*: "The drawing referred to is evidently incorrect in several details. The position of the front legs is wrong and the shape of the body is not fully indicated, whilst a slightly enlarged drawing of the head shows a structure of the mandibles and antennæ not found in the

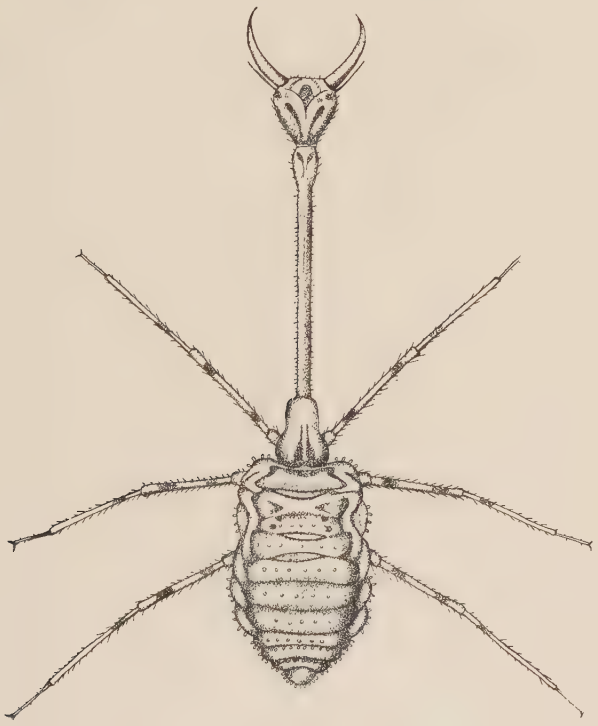

Fig. 1. Larva of *Necrophylus arenarius* Roux (*Pterocroce storeyi* Withycombe) After Eltringham.

specimens examined by the writer, nor evidently in those described by Schaum." And Withycombe disposes of Roux's species in a foot-note: "I am not able to identify this larva with *Necrophilus arenarius* Roux. Roux's figure and description are totally inadequate, and seeing that *Nina cho-*

bauti McL. also occurs in the same locality (Wadi Digla), this might equally be Roux's *Necrophilus*. The larva of *Nina joppana* sp. n. is also very similar to the present larva as will be seen." Neither of these statements seems to me to furnish adequate reasons for introducing the name *Pterocroce storeyi*. There are really two questions involved, namely: Is Roux's larva *Necrophylus arenarius* the same as Schaum's *Necrophilus arenarius*? and is Schaum's *N. arenarius* the same as Withycombe's *Pterocroce storeyi?* If both questions admit of an affirmative answer, Roux's and Withycombe's species are obviously identical.

The first question is the more complicated, since it involves a problem of fact and one of nomenclature. It is true that Roux's drawing is crude, but it was made on a journey and from an insect whose true affinities were quite unsuspected. Even the editor (Audouin) in the above-mentioned foot-note remarks that "the drawing by the author leaves much to be desired." But who expects drawings made nearly a century ago to represent minute structural details with the accuracy demanded by the present-day entomologist? The position of the forelegs and shape of the abdomen in Roux's Fig. 3, criticized by Eltringham, are of little significance because such distortions may be due to the method of mounting or the state of preservation. The more serious discrepancies in the enlarged head (Fig. 4), especially the swollen basal antennal joints and small hairs on the inner borders of the mandibles, are in all probability due to faulty observation. These characters are not indicated in the drawing of the whole specimen (Fig. 3), which would have to be regarded as the first and more authentic figure. It should also be noted that even in the excellent illustrations of Eltringham and Withycombe the joints of the very delicate antennæ beyond the first are not indicated, and an entomologist of the year 2030 might say that these organs consist of a single basal joint with a long apical bristle. There is really no basis for Withycombe's statement that Roux's larva may be the unknown larva of *Nina chobauti*, since the "neck" of *N. joppana* is distinctly shorter and it is therefore more probable that the congeneric *chobauti* would have a "neck" of the same or very similar dimensions. The fact that Wil-

liams took a single female of *chobauti* "at light" at Wadi Digla is no evidence that Roux's specimen was of that species. It is certainly more probable that it belonged to the common larva in the same and other localities about Cairo and that larva is the one identified by Withycombe as *Pterocroce storeyi.* The nomenclatorial problem centers about Schaum's interpretation of Roux's larva. The German entomologist evidently entertained no doubt that his specimens belonged to the same species. He may therefore be said to have validated Roux's generic and specific names as those of his own specimens even if it can never be proved that the specimens taken at Gizeh and Beni Hassan are cospecific.

I believe the answer to the second question, that of the identity of Schaum's and Withycombe's larvæ, is even more clearly affirmative. In the rather extensive collection of larval and pupal Neuroptera accumulated by Dr. H. Hagen during his long association with the Museum of Comparative Zoology, I find two of the 20 larvæ collected by Schaum in 1852. One of them measures 8.5 mm., and is therefore nearly full grown, the other 7.3 mm. They bear Schaum's original label, with the remark: "Häufig auf dem Schutt der Felsengräber von Beni-Hassan, 400′ über d. Nil, freilaufend. Schaum," and additional labels in Hagen's handwriting with an English rendering of the foregoing and "223. Nemoptera sp.—Necrophilus arenarius Roux. Hagen pl. f." These specimens are mentioned by Hagen in his paper on the Nemopteridæ (1888). After expressing his opinion that the larva of *N. arenarius* described by Roux and Schaum is probably that of *Nemoptera (Brachystoma) olivieri,* he adds: "types of the larva are in my collection." On comparing these types, or paratypes as we should now call them, with Eltringham's and Withycombe's figures of the larval *Pterocroce storeyi,* I am quite unable to detect any differences, except in coloration. Withycombe figures and describes a more and a less pigmented "form" of larva, and Hagen's specimens are slightly paler than the latter. This, I am convinced, is due to bleaching by the alcohol in which the specimens have been preserved for nearly 78 years. I conclude, therefore, that Roux's, Schaum's and

Withycombe's larvæ all belong to the same species of Crocine Nemopterid, which should bear the name *Necrophylus arenarius* (Roux) Schaum.

The Crocini obviously constitute a peculiar tribe of Nemopteridæ, with strongly marked larval and adult characters, both morphological and ethological. The adults are small, frail insects with a strongly produced beak-like front, short antennæ and very long, thread-like hind wings. The larvæ have the prothorax produced into a slender and elongate "neck" anteriorly but the attenuation and elongation of this region differ considerably in different genera, being very great in Necrophylus, less pronounced in Nina and much feebler in Croce, as shown by the observations of Maxwell-Lefroy (1909, 1910), Ghosh (1910), and Imms (1911) on the Indian *Croce filipennis*. Withycombe (1924) has been able to study the first instar larva of one of the true Nemopteras *(N. bipennis)* and has shown that it has a very short prothorax and neck, even shorter than in antlion (Myrmeleontid) larvæ.

Ethological observations on the Crocini show that they are to be regarded as cavernicolous insects. The larvæ of the species of Necrophylus and Nina, as we have seen, live in the dust and sand of tombs, caves and rock-cavities, and those of *Croce filipennis* are common in the dust that accumulates on the floors of disused rooms and bungalows, where they feed on Psocids, Lepismids, etc. The adult Crocini fly at dusk or, if during the day, in dark corners, within the confines of the caves, cavities or human dwellings. This is also true of the Spanish *Josandreva sazi*, which was found by Navas (1910) flying at dusk in the cavities of walls and especially in those containing sand or dust. In all probability the larvæ of this delicate insect lives and hunts its prey in these accumulations. The adults of the genus Nemoptera, however, live in the open and may fly by day. At any rate I took quite a number of *N. bipennis* flying or resting on the sparse vegetation of the sun-baked hills about Ronda, Spain (June 30, 1925), at a considerable distance from walls or rock-cavities. The larvæ probably

live in the dust or sand of the open fields like many of the Myrmeleontid larvæ that do not make pits.

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A CLASSIFICATION OF THE PSOCIDÆ

By Nathan Banks

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Cambridge, Mass.

For a long time it has been customary to divide the Psocidæ into two sections according to the number of joints in the tarsi, two or three. By this division certain genera (as Myopsocus and Mesopsocus) were placed with the Trimera, although their venation is practically the same as the typical genus, *Psocus*, with two-jointed tarsi. The venational peculiarity of these higher Psocidæ is in a certain form of stigma, as well as in the modification of the cubital fork to form what is called an "areola postica." The three-jointed tarsi is a primitive character, and should not have as much weight as a special development within the family. I have prepared the following table placing emphasis on this areola postica and the stigma. The number of tarsal joints I would consider as of not more than tribal value; hardly, if any, more valuable than the forked media in hind wing, also a primitive character.

The use of the number of antennal joints as a primary character is open to the same objections as that of the number of tarsal joints, with the added force that the groups overlap. The use of the character of anal and axillary vein in forewing being separate throughout or united at the tip transfers the Amphientominæ from the other scaly-winged species to the group of the true Psocidæ. While there is no doubt that Amphientomum approximates nearer than does any other scaly-winged form, to the true Psocidæ, yet the venation (except for this condition in the anal region) is so close to that of other scaly-winged forms, and so different from the true Psocidæ that it cannot be neglected with reason. Moreover the head of Amphientomum, as well as

pronotum, is much more like that of Perientomum than of any of the true Psocidæ. The presence of scales is also a character of some value. Moreover the genus Psyllipsocus has the anal and axillary ending together, and this surely is not allied to the true Psocidæ.

Perhaps it would be better to consider the scaly-winged species to belong to two families rather than two subfamilies, but I think that the differences between them are not as important as between them and the true Psocidæ. Indeed I think that they form a tendency to run into the Psyllipsocidæ. Embidopsocus I have united with Archipsocus in one family, although it might be better to put each in a family; both are primitive as to the pronotum and some other characters, but have a reduced rather than primitive venation. It is among the scaly-winged species that we find the more primitive forms. On the one side there has been a reduction of pronotum and specialization in venation to the true Psocids, and on the other side a reduction in wing-characters toward the Atropidæ.

The old family Psocidæ I would consder as a superfamily, Psocoidea with the following families, subfamilies and tribes as in the table.

Zorotypus I would also include in the order Corrodentia as the superfamily Zorotypoidea.

I would place *Hemipsocus* in the *Cæciliinæ*; the venation (outside of the cross-vein) is more that of *Cæcilius* than of *Psocus*.

Certain *Epipsocus* show that the separation between the *Cæciliinæ* and *Psocinæ* is not of great moment, and perhaps it would be better to reduce these groups to tribes.

Vulturops Towns. will go in the family *Psoquillidæ*. *Heteropsocus* is the same as *Psoquilla*, but the species is distinct. *Psocinella* and *Psocathropos* differ in length of hind femora. *Notiopsocus* and *Allopsocus* go in the *Peripsocini*. *Rhyopsocus* goes in the *Psylloneurinæ*.

1. No wings, or only scale-like wings without definite venation; no ocelli; tarsi three-jointed, antennæ 15 or more jointed; pronotum visible above *Atropidæ*
   Wings with definite venation present 2

2. Forewings with a definite stigma; cubital fork developed into an "areola postica" with a narrowed base, or else no cubital fork; the first fork of median vein never reaches back to near base of stigma; anal and axillary end in one point; wings not scaled; 3 ocelli; pronotum rarely distinct from above; antennæ 13 jointed; tarsi two- or three-jointed *Psocidæ*
No distinct stigma, if one apparent then wing scaled and the first fork of median vein reaches back nearly as far as base of apparent stigma; no areola postica with narrowed base, the cubital fork is a normal fork, usually long; anal and axillary often separate at tip; ocelli present or absent, antennæ usually more than 13 jointed; tarsi three-jointed; pronotum often distinct from above 3

3. Wings clothed with scales; both wings present, veins reach to margin *Perientomidæ*
Wings not with scales 4

4. No hind wings, or extremely minute; venation reduced, some very long bristles; no ocelli; anal and axillary separate, meso- and metathorax separated, pronotum visible from above *Psoquillidæ*
Hind wings of fair size; usually ocelli 5

5. Venation complete, that is all main veins reach margin, two or three branches end in costa, pronotum not particularly prominent from above; antennæ 20 or more joints *Empheridæ*
Venation reduced, some veins not reaching tip; pronotum very prominent from above; meso-and metanotum separate; antennæ 13 to 15 jointed, eyes not hairy *Embidopsocidæ*

Tables to Subfamilies and Tribes

Atropidæ

Claws without tooth; meso- and metanotum separated; antennæ 22 or more joints, wings absent or scale-like *Atropinæ*

Claws with a tooth; meso- and metanotum united, antennæ 15 jointed; no wings *Troctinæ*

Psoquillidæ

The few genera do not readily separate into groups.

Embidopsocidæ

Two longitudinal veins unbranched *Embidopsocinæ*
Two longitudinal veins branched and connected *Archipsocinæ*

Empheridæ

Hind wings with median forked *Empherinæ*
Hind wings with median simple *Psylloneurinæ*

Perientomidæ

Anal and axillary end in one point antennæ 13 jointed or a few more; no closed cell near middle of fore wing; media of hind wing simple *Amphientominæ*

Anal and axillary separate at tip; usually a small closed cell near middle of fore-wings; median of hind wings forked; antennæ 20 or more jointed. *Perientominæ*

Psocidæ

1. In hind wing median vein forked; wings sometimes partly netted *Calopsocinæ*
   Median vein of hind wings simple 2

2. Areola postica (sometimes absent) free, or if connected to media then its end is as far out as end of stigma *Cæcilinæ*

   Areola postica present and either united at top to media or connected by a cross-vein, and usually ending before end of stigma 3

3. Radius (near base of radial fork) connected a second time to the media, thus forming two closed cells near middle of wing ..... *Thyrosophorinæ*
Radius connected but once to media, and thus forming but one closed cell near middle of wing ..... *Psocinæ*

Calopsocinæ

Hind edge of head sharp; venation partly netted *Calopsocini*
Hind edge of head rounded; venation not netted *Ptiloneurini*

Cæcilinæ

1. Stigma veined, no cubital fork ..... *Neurostigmini*
Stigma not veined 2
2. No cubital fork ..... *Peripsocini*
Cubital fork present 3
3. Tarsi 2 jointed 4
Tarsi 3 jointed, head broad at eyes ..... *Mesopsocini*
4. Hind edge of head rounded ..... *Cæcilini*
Hind edge of head sharp ..... *Dypsocini*

Psocinæ

1. A cross-vein between stigma and radius ..... *Stenopsocini*
No such cross-vein 2
2. Tarsi 3 jointed ..... *Myopsocini*
Tarsi 2 jointed ..... *Psocini*

Thyrsophorinæ

The few genera here do not require tribes.

FOUR NEW SPECIES OF PSAMMOCHARIDÆ

By Nathan Banks

Museum of Comparative Zoology, Cambridge, Mass.

Cryptocheilus cressoni sp. nov.

♀ Black, antennæ mostly yellow, wings yellowish except dark base and tip; body only moderately hairy, also coxæ, femora only slightly above. Third joint of antennæ much longer than the fourth; lateral ocelli much nearer to each other than to eyes; pronotum angulate behind; propodeum coarsely transversely ridged, these ridges often weaker in the middle area of the posterior face; long spur of hind tibiæ about one-third of basitarsus; second ventral segment of female with two humps more or less distinct. Third cubital cell but little longer than the second, reaching much beyond the radial cell. The subgenital plate of the male has a median, elevated, punctured, spatulate area not reaching tip of plate, but with a median projection toward the tip.

Length 15 to 20 mm.; forewing 17 mm.

Specimens come from Fedor, Dallas, and Austin, Texas. Others from N. Mex., Arizona, Utah, and California have the elevated part of subgenital plate longer. It has been considered as *C. flammipennis* Smith which is a San Domingo species.

Lophopompilus azotus sp. nov.

♀ Black; head, thorax, abdomen and basal joints of legs strongly sericeous; the lower part of pronotal lobes almost snow-white, and also the lower lateral edges of the dorsal plates of abdominal segments one to three. Pilosity and structure similar to *L. æthiops*, but the hair is rather shorter and less dense, most noticeable on the head; the emargination of clypeus is as deep as in *L. æthiops*. It may prove to be but a variety of that species, but the coloration is so different that it deserves a name.

From Springfield, South Dakota 14 Sept. (H. C. Severin).

Aporinellus semirufus sp. nov.

♀ Head and thorax black, sericeous, especially on the clypeus; abdomen wholly red above and below; legs mostly

black, tarsi brown, hind femora and tibiæ red; antennæ black. Pronotum and part of pleura sericeous. Wings hyaline, apex dark. Vertex considerably narrowed above, hind ocelli much closer to the eyes than to each other; third joint of antennæ plainly longer than the fourth; front tarsi with comb of long spines. Wings short and small, marginal cell fully twice as long as broad, submarginal short, not one and and a-half times as long as high, the two sides nearly meeting above, first recurrent vein received before the middle, second recurrent interstitial with end of the submarginal cell.

Length 6 mm.

From Martin, South Dakota, 12 Sept. (H. C. Severin). At once separated from *A. rufus* by thorax and base of antennæ black. In structure it is near to *A. ferrugineipes,* both in wings and head, but differs in the red abdomen.

Planiceps hesperus sp. nov.

Black; clothed with minute appressed pubescence, on vertex, pro- and mesonotum rather brownish, on clypeus, propodeum, pleura, and coxæ white; last dorsal segment of abdomen of female red-brown; wings nearly uniform blackish. Face broad, scarcely narrowed above, vertex straight across, lateral ocelli about as near to eyes as to each other; pronotum long, fully two-thirds as long as broad in female, in male much shorter, nearly straight behind; propodeum without distinct furrow; legs with few very short spines on tibiæ, long spur of hind tibia little more than one-half of basitarsus in the female, in male fully two-thirds of basitarsus. Wings with marginal cell small, more than twice its length before tip of wing, second sub-marginal cell small, triangular, receiving both recurrent veins, the discoidal cell below this very short, basal vein strongly bowed basally.

Length ♀ 4.5 mm., ♂ 3 mm.

Lone Mt., San Francisco, Calif., 25 April, 4 July (F. X. Williams).

In venation as well as general structure it is very similar to the eastern *P. pulchellus,* but separated by the black abdomen.

ON THE DRYOPID BEETLE GENUS LARA

By P. J. Darlington, Jr.

Collecting at North Bend, Washington, in July, 1927, yielded a large series of the dryopid genus Lara, which was described in 1852 by Leconte (Proc. Acad. N. S. Philadelphia 5, 1852, p. 42.) to contain a single species from California. Superficial examination showed at once that there were two species represented in the Washington material. Comparison with the type of *L. avara* Lec. proved further that the insect I had at first identified as that species was at least subspecifically distinct, so that it is now possible to discriminate two new forms and at the same time to give a brief account of their habits.

In our fauna Lara is an isolated genus of the Potamophilini, seeming to be, as Leconte says in the original description, "the desired link connecting the anomalous Eurypalpus (Psephenus) with the true Parnidæ. There are several apparent relatives, such as Disersus, in Central and South America, however. Leconte's description of Lara is sufficiently full, and the genus has been figured by Horn in the Trans. American Ent. Soc., **10**, 1882, Plate 6, fig. 16.

Key to the Species of Lara

Pronotum with the hind angles acute, but scarcely more prominent than the middle lobes; elytral pubescence uniform . *L. gehringi*

Pronotum with the hind angles acute and prominent; alternate elytral intervals with the pubescence less decumbent, so that the elytra appear dark with sericeous lines.

Size larger; elytra wider as compared with the prothorax; pronotum proportionately longer, narrower, and with more prominent front and hind angles. *L. avara amplipennis*

Characters opposed to those above *L. avara avara*

Lara gehringi sp. nov.

Text figure "a".

Black throughout. Punctuation and pubescence above and below almost as in *Lara avara,* except that there is no alternation of pubescence on the elytral intervals. General form similar to that of *L. avara,* but the pronotum less strongly convolved and its side margins less strongly sinuate throughout. Hind pronotal angles only moderately prominent, scarcely more so than the sides of the pronotum at middle. Genitalia of ♂ definitely more decurved apically than in *L. avara.*

Length to apex of elytra 5.7—6.5 mm.

The ♂ holotype and one ♂ paratype are from NORTH BEND, WASHINGTON, July 28, 1927. One ♂ paratype is

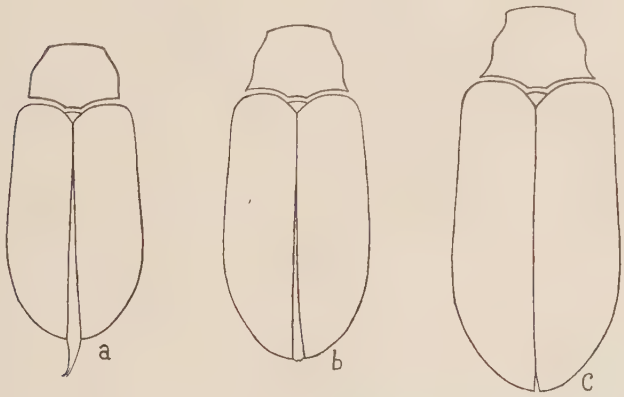

Fig. 1. Outlines of pronotum and elytra of **a**, *Lara gehringi;* **b**, *Lara avara avara;* **c**, *Lara avara amplipennis.* All are magnified about 6.5 diameters.

from BARTLETT SPRINGS, CALIFORNIA, collected by A. Fenyes. The holotype is in my own collection, the North Bend paratype in the collection of Dr. J. G. Gehring, and

the Californian paratype is returned to Mr. H. C. Fall, who very kindly loaned the specimen to me for the present study.

The important diagnostic characters of *Lara gehringi* are set forth in the key. The Californian specimen differs from the other two in being a little more shining above.

I take great pleasure in naming this species for Dr. John George Gehring, who was almost my first entomological correspondent, and to whom I owe my western trip of the summer of 1927.

Lara avara amplipennis subsp. nov.

Text figure "c".

Generally similar in form and sculpture, as well as genitalia, to typical *Lara avara,* but larger, with the elytra a little wider as compared with the prothorax. The pronotum is proportionately a little longer and narrower, with both the anterior and posterior angles more prominent. These differences taken together give the insect a recognizably modified appearance, although they do not impress one as being of specific value. There seem to be no external differences between the sexes.

Length to apex of elytra (*amplipennis*) 7.3—8.1 mm.
(*avara*) 6.8—7.2 mm.

Length of an elytron (*amplipennis*) 6.1—6.5 mm.
(*avara*) 5.2—5.4 mm.

Since the total length depends partly on the insect's position at death, the measurements of elytral length show the comparative size of the two subspecies more accurately.

Holotype ♂ from NORTH BEND, WASHINGTON, July 28, 1927, in my collection. Paratypes: 49 ♂♂ ♀♀ from the type locality, July 27-31; 2 ♂♂ from REVELSTOKE, BRITISH COLUMBIA, August 14, 1927. Paratypes in the Museum of Comparative Zoölogy, the United States National Museum, the California Academy of Sciences, the Canadian National

Collection, and the private collections of Mr. H. C. Fall, Dr. J. G. Gehring, and the writer.

This series of *amplipennis* has been compared with the type and one other Californian specimen of true *Lara avara* in the Leconte Collection in the Museum of Comparative Zoölogy at Cambridge. For the privilege of making this comparison I am indebted to the authorities of the museum, and particularly to Professor Nathan Banks, Curator of Insects.

Horn speaks of having seen a specimen of *Lara avara* on a log under water in a swift stream. I found the genus only on log jams in large streams which were both swift and cold. The insects behave much like Psephenus, but are, perhaps, less alert, for they are usually found on the lower sides of projecting stubs or in crevices, just at water level. They are among the most resourceful of beetles in the presence of danger, for they can choose between crawling down a log into deep water, flying, or dropping into the current, which whirls them swiftly away. The majority ride the current for a yard or two and then take wing. I owe my fine series of the genus almost entirely to a systematic but temporarily unsuccessful search for *Amphizoa striata* Van Dyke, of which North Bend is the type locality.

THE TRACHEAL SYSTEM OF THE MATURE LARVA OF *PYRAUSTA NUBILALIS* HUBN.[1]

By Milton F. Crowell

The tracheal system of the larva of the European corn-borer, *Pyrausta nubilalis* Hubn. (Lepidoptera; Pyralididæ) is of the peripneustic type. There is one pair of functional spiracles on the thorax, and eight pairs on the abdomen. (Fig. 1). These spiracles open into short stout tracheæ which lead, on each side, to a large longitudinal trachea which runs throughout the length of the body, and from which branches go to the various body organs.

The Spiracles

The spiracles are of the type described by Kranchner, according to Packard (1909), as "bearing lips." The lips are represented by a chitinous ring surrounding the elliptical opening through the body wall. They are "roof-like," or bent inwards, and are hairy. (Fig. 2). From the spiracle a short stout trachea joins the adjacent longitudinal trunk. (Fig. 3).

The Tracheal Closing Apparatus

The tracheal closing apparatus (Fig. 3) surrounds the short trachea between the spiracle and the main trunk. On one side of the trachea, extending about half around it, is a chitinous band, the *closing bow*. Attached to one end of this bow is one extremity of the *closing lever*. The closing lever runs parallel with a line joining the ends of the closing bow, to a point almost halfway between the ends of the bow. Here the lever turns abruptly away from the

center of the trachea at approximately a right angle. The projecting arm thus formed is somewhat larger than the other arm and swells slightly toward its free end. The lever is chitinous. Between the apex of the lever and the end of the closing bow opposite to that to which the lever is attached is a third chitinous piece. This is the *closing band.*

The contraction of a muscle extending between the free arm of the lever and the closing band causes the lever to move. The attachment of the lever to the closing bow becomes the fulcrum, and the action of the muscle pulls the apex of the angle of the lever inward, causing the space between the lever and the closing bow to become constricted. The closing band is so attached to the apex of the angle that the end of the band is depressed inward, causing the space between it and the closing bow to be constricted. The trachea is thus pinched together.

This structure is cast with the exuvia when molting takes place.

Kranchner (1880), who first described the tracheal closing apparatus of insects, expresses the opinion that it originates as a local thickening of the tænidium.

The description of the spiracles and closing apparatus is taken from a former paper, (Crowell, 1926).

The Longitudinal Tracheæ

In the embryo the tracheal system arises as ectodermal invaginations which grow deeper, and from which branches are sent out. One running forward fuses with one running backward from the next anterior spiracle, and one running backward fuses with one running forward from the next posterior spiracle. Thus, longitudinal connections are formed between the spiracles, and these connections form the main longitudinal tracheæ. In the thorax there is a longitudinal system on each side dorsal to the main system. It is formed by the joining of dorsally running branches.

The longitudinal tracheæ lie on each side in an area between the small dorso-recti muscles and the great ventro-

recti muscles. In this area there are no longitudinal muscles, but it is crossed by sterno-tergal muscles.

Lying in front of all of the spiracles, except those in the prothorax, is a sterno-tergal muscle, and the longitudinal trachea except in the mesothorax and in front of the first abdominal spiracle, passes between these muscles and the body wall. In the prothorax the sterno-tergal muscle lies behind the spiracle. In the metathorax a large branch from the main trachea passes beneath this muscle. In the mesothorax the muscle is present and a trachea arising in a manner similar to the branch in the metathorax passes between it and the body wall. Thus in each body segment through which the main trachea runs it is held to the body wall by a muscle passing over it. (Fig. 4. The trachea is much longer in proportion to its thickness than here indicated).

According to De Guyse (1926) the primitive position of the spiracle located on the prothorax was in the membrane between the prothorax and mesothorax, and it has moved ahead to its present position. That would account for the fact that the sterno-tergal muscle lies behind the spiracle rather than in front of it, as in the abdomen.

DeGuyse (1926) explains the positions of the muscles in front of the first abdominal spiracle, and in the mesothorax, from a consideration of the larvæ of *Sthenopis* (Hepialidæ), as follows:

The thoracic spiracles are situated at a much lower level than those of the abdomen. In the abdomen the anterior lateral branch arising from the short spiracular trachea passes under the sterno-tergal muscle and anastomoses with the posterior lateral branch from the next preceding segment. The anterior lateral branch from the first abdominal spiracle passes as usual under the muscle, but since the second thoracic spiracle is at a much lower level, its posterior lateral branch fails to meet the anterior lateral branch from the abdomnial spiracle. The latter loses itself among the dorsal muscles. At the same time the lower visceral branch is found greatly enlarged, and anastomosed with a posterior branch of the first thoracic spiracle. The

second pair of spiracles thus loses its connection with the general respiratory system and ceases to function.

That means that the apparent branch in the metathorax, arising from the apparent main trachea and passing beneath the muscle, is, in fact, the main trachea, and the apparent main trachea is a branch. But it is hard to explain the tracheal branchings in the mesothorax on this basis.

The branch from the first abdominal spiracle passing forward beneath the sterno-tergal muscle, does not, in *Pyrausta nubilalis* "lose itself among the dorsal muscles," but becomes a part of the dorsal longitudinal system, sending branches to the metathoracic leg and to the wing-bud.

Figure 5 and figure 6 show the branches arising from the first and fourth abdominal spiracles, respectively. In the case of the branches arising from the first abdominal spiracle it is evident that the presence of the appendages of the metathorax, legs and wings, has made necessary more tracheal branches than are called for in the fourth segment where such appendages are absent.

But a study of the branches arising from the fourth abdominal spiracle fails to show any that takes over the role of the main trunk, if we consider that the branch from the first abdominal spiracle from which spring the tracheal supplies to the alimentary tract, the wing-bud, and leg, to be the anterior branch, or "main tracheal trunk" from that spiracle.

The apparent main tracheæ, the "lower visceral branch" of de Guyse, does not meet the posterior branch from the prothoracic spiracle until after it throws out branches in the mesothorax that are at least analogous with the branches from the first abdominal spiracle. (Fig. 7). It is rather difficult to see how these branches arose as secondary branches from the lower visceral branch from the first abdominal spiracle and the posterior branch from the prothoracic spiracle.

The Transverse Tracheæ

The longitudinal tracheæ of each side are connected by transverse tracheæ in every spiracle bearing segment, ex-

cept, possibly, the first abdominal. There is one in the mesothorax, although that segment does not bear a functional spiracle. There is one in the head.

The transverse trachea in the head lies in front of the supraœsophageal ganglion and just behind the body of the tentorium. The posterior arms of the tentorium pass above the trachea, close to its junctions with the main longitudinal tracheæ. This transverse trachea lies above the commissures between the supra- and subœsophageal ganglia. (Fig. 8).

Peterson (1912) describes and figures a cross trachea in the larva of the tomato-worm, *Protoparce carolina*, lying above the commisures between the supra- and sub-œsophageal ganglia, but in the tomato worm this trachea crosses the subœsophageal ganglion. In *Pyrausta nubilalis* it lies well in front of the ganglion. Peterson says nothing about the relation of this trachea to the tentorium, but from his figure, the trachea must lie well behind it.

The next cross trachea, which I have numbered 2-a, is a secondary branch. The primary branch from which it springs comes from the main trachea just after it leaves the prothoracic spiracle and its other branches will be described later.

Trachea 2-a runs on the outside of the muscle layer, and beneath the central nervous system.

In the prothorax there is a transverse system of tracheæ dorsal to the alimentary tract. These tracheæ are arranged in such a manner that I term the system the *diamond*. (Fig. 9).

A large branch arises from the thoracic spiracle. It runs forward a short distance, then branches into two good sized tracheæ, the larger being in front. Each of these branches meets a corresponding branch from the opposite side, and the double Y thus formed gives the shape that justifies my name for the arrangement. From the forward apex of the diamond branches go into the head. From the posterior apex a long branch goes backward and joins a branch from the main trunk that runs backward from the prothoracic spiracle Thus, counting each branch separately there are

three transverse connections crossing the ailmentary tract between the prothoracic spiracles.

Peterson (1912), in the tomato-worm, finds that in all cases except the transverse tracheæ described above, the cross tracheæ lie ventral to the nervous system. This is not always true in *Pyrausta nubilalis.*

Just behind the prothoracic spiracle there is a trachea, which I have numbered 1. This lies on the inner surface of the muscle layer. It crosses the nerve cord dorsally, terminating, usually, in the prothoracic ganglion. Near the base of the ganglion the trachea meets the corresponding trachea from the other side, and a cross connection, dorsal to the nervous system, and ventral to the alimentary tract, is formed (Fig. 10). Trachea 1 varies. It may be much reduced, forming only a very weak connection with the central nervous system, with the corresponding trachea of the opposite side entirely absent (Fig. 11). Sometimes the trachea to the ganglion is obviously from the left side, with the trachea from the right meeting it (Fig. 12), and sometimes the opposite is true. The branches from trachea 1 usually supply the muscles, but in one specimen a large branch ran to the nerve cord in front of the mesothoracic ganglion. (Fig. 13). In the figures the size of the tracheal connections with the ganglion is exaggerated.

Trachea 1 lies, apparently, at the junctions of the longitudinal muscles of the prothorax with those of the mesothorax, and is a useful landmark in locating the limits of these segments.

The next transverse trachea I have numbered 2 (Fig. 14). It lies in the mesothorax on the outer side of the muscle layer. It passes beneath the central nervous system just in front of the mesothoracic ganglion. In relation to the muscles and the nervous system and to tracheæ 1 and 3, which will be described next, it is, if not homologous to trachea 2-a, analogous to it.

Trachea 3 lies on the inner surface of the muscle layer and approximately marks the limits of the mesothorax behind and of the metathorax in front. It is a transverse trachea much as is trachea 1. A branch to the mesothoracic ganglion meets a branch from the opposite side, forming a

cross tracheal connection dorsal to the nervous system and ventral to the alimentary tract (Fig. 15).

Trachea 4 lies in the metathorax. It is on the outside surface of the muscle layer and crosses just in front of the metathoracic ganglion. It is similar to trachea 2.

The system of numbering is now evident. Beginning with the first trachea behind the prothoracic spiracle lying on the inside of the muscle layer, extending toward the mid-ventral line of the body, which trachea I have called 1, the tracheæ in each segment behind this that lie on the inner surface of the muscles at about the line between the segments have *uneven* numbers. Those transverse tracheæ lying in the segment and on the outer surface of the muscle layer have *even* numbers.

Trachea 5 is not a transverse trachea; and the tracheæ in the abdomen analogous to tracheæ 1, 3 and 5, are not transverse tracheæ.

Trachea 6 lies in the first abdominal segment. From its position on the outside of the muscles and from the distribution of its branches, which will be discussed later, it is analogous, if not homologous to the other tracheæ of like position (those with even numbers). But unlike tracheæ 2 and 4, and unlike the corresponding tracheæ in the abdominal segments, trachea 6 is not, as a rule, a transverse trachea. In one specimen I found a connection with the corresponding trachea from the opposite side. I doubt if that was typical. But it must be considered in connection with the transverse tracheæ because of its position. (Figs. 16, 17).

Behind the first abdominal segment there is a transverse tracheal connection in each spiracle bearing segment. From the second to the seventh segments inclusive, this transverse trachea is analogous to tracheæ 2 and 4, except that they lie behind, rather in front of, the ganglia.

In the eighth segment there is a stout connection between the spiracles lying above the alimentary tract.

Peterson (1912) in speaking of the tomato worm says: "In the case of the eighth abdominal segment, only one minute dorsal cross trachea was found, while in the prothoracic region two distinct cross tracheæ were observed."

Pyrausta nubilalis differs from the tomato worm in that the cross trachea in the eighth segment of the abdomen is not minute, but is a stout connection. In the prothorax the connections are apparently similar, but Peterson shows no tracheal connection between the posterior apex of the diamond and the main trunk.

Tracheæ from the Prothoracic Spiracle

The arrangement of the tracheæ from the prothoracic spiracle (Fig. 18), from which the organs of the prothorax and head are supplied, is much more complicated than that in the regions of the body behind the prothorax. It is easier to describe these tracheæ as from the prothoracic spiracle than to attempt to correlate them with the study of the tracheal supplies to various systems of organs.

From the spiracle two large branches extend towards the head. One of these I believe, for reasons to be set forth later, represents the main longitudinal trachea, or the anterior branch from the spiracle. The other branch forks a short distance in front of the spiracle, and its inner branch forms the stem of the Y which makes up one side of the dorsal transverse tracheæ to which I have referred as the diamond. The outer branch goes forward into the head. There it branches, and apparently supplies the great mandibular muscles lying in the side of the head. One branch was traced to the region of the base of the antenna, but I was unable to follow it into that organ.

The other large branch going into the head from the spiracle branches almost immediately. This first branch sends out a small branch, and three larger branches of about equal size. The small branch goes toward the head. The branch nearest the head of the other three branches passes at once to the outer surface of the muscle layer. It runs toward the middle of the body, and sends a branch to the prothoracic leg. It continues, and sends a branch upward to the prothoracic ganglion. Then it meets the corresponding trachea from the opposite side, forming a transverse connection ventral to the central nervous system. In its position and its branching to the ganglion, but not to

the leg, it resembles the transverse tracheæ to which I gave even numbers, and is the trachea which I designated as 2-a.

The middle of the three branches runs on the inner surface of the muscle layer and sends branches to the prothoracic and subœsophageal ganglia, and to the muscles.

The hindmost branch also runs on the inner surface of the muscle layer. It crosses the muscles, and bending ventrally sends a branch to the prothoracic leg.

The middle and hindmost branch, taken together, are, in their position and distribution so similar to trachea 3 that I believe them to be at least analogous to the tracheæ with uneven numbers. Therefore I have numbered them together as branches of trachea 1-a.

The next large branch from the main trachea runs largely across the dorsal surface of the muscles inside of the head, apparently supplying them.

A small branch runs from the main tracheal system to the supraœsophageal ganglion.

Just in front of this ganglion, and lying so that the main tracheal branch is just behind the body of the tentorium, is the first transverse trachea described above. There are two branches from this trachea extending backward. Sometimes they go to the subœsophageal ganglion (Fig. 18), and sometimes they end in the nerve cords anterior to it. In sending these branches to the nervous system, this trachea resembles tracheæ 2, 4, etc., but in lying above the neural commissures it differs from them.

In describing the main tracheæ from the spiracle I said that two large branches extend toward the head. From one springs the half of the dorsal transverse system forming the diamond. From the other spring branches 2-a, 1-a, the trachea to the supraœsophageal ganglion, and the first transverse connection, I believe that these branches indicate that this trachea is the main longitudinal trunk, and not the one giving rise to the diamond. For, as will be shown, the transverse tracheæ supplying the ganglia of the body segments posterior to the prothorax always spring directly from the main trunk near the spiracle. If it is true that the anterior arm of the tentorium is formed from an invagination of the body wall representing the spiracle

of the mandibular segment (Comstock and Kochi 1902), it is not unreasonable to imagine that the first transverse tracheæ indicate, at their point of origin, the positions of the branchings from a spiracle, and that it is here that the main longitudinal trachea ends, rather than at the prothoracic spiracle.

From just in front of the base of the transverse trachea two tracheæ of about equal size run forward. The inner one ends in two short branches, one to the maxilla, and one to the labium. The outer trachea sends branches into the mandible, and a branch to the region of the base of the antenna. I was unable to trace this into the antenna. A small branch from the trachea to the supracesophageal ganglion runs forward and joins one of the mandibular branches.

The other tracheæ arising from the prothoracic spiracle are the posterior branch going into the formation of the main longitudinal trachea, and a branch also running backward which joins the trachea to the posterior apex of the diamond. Branches also go from this backward running branch to muscles and fat bodies, and a branch divides into tracheæ supplying the appendages of the mesothorax.

Tracheæ to the Nervous System

The tracheæ to the supra- and subœsophageal ganglia, and to the prothoracic ganglion have been described.

The mesothoracic ganglion is supplied with air by tracheæ 2 and 3. Trachea 2 sends a branch backward to the ganglion, and trachea 3 sends one forward as described.

Trachea 3 lies on the inner surface of the muscle layer and sends many branches to the muscles (Fig. 15). Its main branch runs around the edge of the muscle layer and, turning downward, extends into the mesothoracic leg.

Trachea 5 differs from trachea 1 and 3 in that it does not connect with the corresponding trachea from the opposite side. It sends branches to the muscles and its forward branch runs around the edge of the muscle layer, and turning downward, enters the metathoracic leg. It also

sends small branches to the metathoracic and first abdominal ganglia. (Fig. 19).

The metathoracic ganglion receives, in addition to the small branches from trachea 5, branches from trachea 4. These run backward, one on each side, to the ganglion. (See Fig. 14, representing trachea 2).

The first abdominal ganglion receives, on each side, a small branch running forward from trachea 6, as well as branches from trachea 5. (Figs. 16 and 17).

The abdominal ganglia receive their air supply from the transverse tracheæ. In the abdomen these all are found on the outside surface of the muscle layer. The tracheæ corresponding to tracheæ 1, 3, and 5, do not enter the nervous system. Another difference is that in the thorax the transverse tracheæ of even number, 2 and 4, lie in front of the ganglia and send their branches backward to them, while in the abdomen the transverse tracheæ lie behind the ganglia, and the branches to the ganglia run forward. The tracheæ that form the transverse tracheæ in the abdomen divide into an anterior and posterior branch. It is the posterior branch that meets the corresponding trachea from the other side, forming the transverse connection, and from this branch, also, that the branch divides that supplies the ganglion. The anterior branch may send branches to the ganglion, but apparently more often it does not. (Fig. 20).

The seventh and eighth abdomnial ganglia have coalesced and lie in the seventh abdominal segment. The trachea that normally would supply the seventh ganglion here supplies both. There is no separate connection between the eighth ganglion and the tracheal system. (Fig. 21).

Peterson (1912) figures two transverse tracheæ in the tomato-worm larva sending branches to these ganglia, the one supplying the seventh passing under the eighth, and the trachea sending branches to the eighth is apparently the transverse trachea between the spiracles of the eighth abdomnial segment. Careful search failed to discover any trachea from this transverse trachea to the nervous system in *Pyrausta nubilalis*.

The commissures between the ganglia are usually supplied by branches from the transverse tracheæ. In the ab-

domen there are branches between the branches to the ganglia, that run backward, usually one on each side of the mid-ventral line, and small branches from these sometimes enter the commissures. (Fig. 22). Lubbock, (1860) states that he found the commissures of adult Lepidoptera to be without tracheæ, but the commissures in the larvæ well supplied.

Occasionally the nerves from the ganglia have short tracheæ in them. This is more often the case at their origin, where a branch from the ganglion-supplying trachea often enters them (Fig. 23). Sometimes a small branch from the thoracic tracheæ, 3 and 5 will go to the nerve trunk (Fig. 24). In one specimen the anterior branch from the transverse trachea in the seventh abdominal segment sent a branch to a nerve originating in the seventh abdominal ganglion. (Fig. 25).

Tracheæ to the Appendages. (Fig. 26)

The tracheæ to the mandibles, maxillæ and labium have been described above. In the section describing the tracheæ from the prothoracic spiracle the courses of the tracheæ to the prothoracic leg were described. To briefly review:

The ventral trachea 2-a sends a branch to the leg; so does a branch of trachea 1-a. Both 1-a and 2-a spring from the same branch from the main trunk. The tracheal supply of the prothoracic leg, combined as it is with the supply to the nervous system, differs from that of the meso- and metathoracic legs, but resembles, somewhat the tracheal supply of the abdominal prolegs.

The mesothoracic leg receives its tracheæ from three sources. First a large branch from near the prothoracic spiracle runs backward. This sends a branch to the posterior apex of the diamond. Behind this branch, the trachea divides into a Y, the inner arm of which runs on the outer surface of the muscle layer toward the middle of the body, and forms the anterior stem of the leg tracheæ. The outer arm of the Y runs backward and joins, in the wing-bud, with a forward running branch of the next large outer branch of the main trachea. This large branch springs

from the main trunk behind, and on the opposite side to, trachea 3. It runs forward and its second branch is the outer arm of a Y which joins, in the wing-bud, the outer branch of the Y in the other trachea. The inner arm of this Y runs toward the center of the body, forming the posterior stem of the leg trachea, and anastomosing with the inner arm of the Y from the trachea arising near the prothoracic spiracle and the trachea formed by this union goes to the leg. Thus the mesothoracic leg is supplied by tracheæ from origins before and behind. Also, a branch of trachea 3 ends in the leg, making the supply from behind a double one.

The tracheæ to the metathoracic leg are similar to those to the mesothoracic leg. There is an anterior stem, arising from a branch from the main trunk, and a posterior stem arising from a forward directed branch of the main trunk. The branches of the main trunk also send branches out that meet in the wing-bud. These branches joining in the wing-buds of the meso- and metathoracic segments constitute the dorsal longitudinal trunk of the thorax. Trachea 5 sends a branch to the metathoracic leg in the same manner as does trachea 3 to the mesothoracic leg.

In the pupa of *Antheraæ pernyi* Guer., according to Enderlein, (1902), the arrangement of the tracheæ to the legs is very different from that of the larva of *Pyrausta nubilalis*. The prothoracic leg is supplied by two branches from the trachea to the antenna, and by two branches from a branch to the supraœsophageal ganglion, making four tracheæ enter this appendage. The meso- and metathoracic legs are each supplied by a single trunk.

Peterson (1912) figures the tracheal system of *Protoparce carolina* without showing the distribution of the branches, except in the case of the legs, and here he shows but a single trachea to each of them.

Chapman (in Comstock 1918) figures the tracheation to the meta- and mesothoracic legs in the pupa of *Antheræa roylei*, and his figure agrees, in the main, with the distribution shown by *Pyrausta nubilalis*. He does not show the supply to the prothoracic leg.

Regarding Enderlein's figure, Chapman says: "The con-

ditions of the tracheæ seem to be so constant in representatives of this order (Lepidoptera) which have been studied that it would seem very improbable that there should be such a great difference between two members of the same genus as Enderlein's figure would indicate."

Peterson's figure was drawn from a ventral dissection, and in the case of *Pyrausta nubilalis*, the tracheal supply to the prothoracic leg cannot be properly seen from this aspect, for the spreading of the insect breaks the transverse trachea 2-a, and the leg then appears to have either but one branch to it, or if two branches are seen to enter the leg, the transverse character of 2-a cannot be seen. With regard to the meso- and metathoracic legs, the least that can be said is that in the European corn borer their supply is very different from this supply as shown by Peterson in the tomato-worm.

The tracheal supply to the proleg of the third abdominal segment is shown in Figure 27. It is a branch running almost directly downward from, and at right angles to, the posterior branch of the trachea supplying the ganglion of the segment. The proleg trachea divides shortly after leaving the main branch, and two branches enter the leg. The anal proleg is supplied by a long branch running backward from near the eighth abdominal spiracle in a manner suggestive of the branch running forward, in the head, to the mandible. (Fig. 28).

The tracheal supply to the wing-buds has been described, and is apparent in the figure (Fig. 26).

Tracheæ to the Alimentary Tract, Fat Bodies, Silk Glands and Malpighian Tubules

The tracheæ to the alimentary tract, fat bodies, silk glands and Malpighian tubules must be treated largely under the same heading, for they are all branches from the same stems.

A large branch arises from the main tracheal trunk near its junction with the spiracular trachea. This branch runs across the body cavity and splits into branches, most of which supply the alimentary tract. These branches from

the main trunk are found arising from near the first to the eighth abdominal spiracles. None rise in the thorax.

Alimentary Tract

The trachea to the alimentary tract arising from near the first abdominal spiracle is different in origin from that observed in the other tracheæ supplying the tract. It does not arise directly from the main trachea, but is the first branch from the trachea that also gives rise to the posterior stem of the metathoracic leg tracheæ. The other tracheæ to the alimentary tract arise directly from the main longitudinal trunk.

The figure illustrating the tracheæ to the alimentary tract, (Fig. 29), shows the trachea arising near the first abdominal spiracle, and supplying that part of the tract just behind the œsophagus. In the figure this portion of the alimentary tract is shown much distended. As a rule the alimentary tract behind the œsophagus, from which it is distinctly separated, is of more or less uniform diameter throughout its length. This particular specimen is chosen for illustration, however, because the enlargement spreads the tracheæ, making their distribution easier to trace.

The supplying trachea arises as a branch of a trachea arising from the longitudinal trachea near to the spiracular trachea. The supplying trachea runs forward and upward, breaking into four main branches, one running forward and one running backward on the dorsal surface of the tract, and one running forward and one running backward on the ventral surface. These, with their branches, enclose the tract in a sort of basket of tracheæ.

This same arrangement appears in the tracheæ to the alimentary tract behind the first abdominal segment.

The œsophagus is poorly supplied with tracheæ. Sometimes a very small branch will enter it, but there is no basket-work of tracheæ around it, and no main tracheal branch to it.

Fat Bodies

The fat bodies are large masses of white material distributed within the body cavity somewhat as follows: A

mass on each side of the alimentary tract in the forward end of the thorax; a large mass which extends across the thorax below the alimentary tract, and which, therefore lies on both sides of the tract as well as beneath it; next come two large masses which largely fill the cavity of the abdomen; two masses, one on each side of the alimentary tract in about the seventh abdomnial segment; and a large mass in the caudal end of the body which lies on each side of the alimentary tract, and ventral to it. The large middle masses, one on each side, extend from about the first to the seventh abdominal segments; they are made up of large lobes, and each segment apparently has a lobe lying in it. No definite distribution of these bodies is made here with regard to the individual body segments, either in the thorax or abdomen, since they overlap each other. These are the large masses of fat that have been said to be storage of nutriment for metamorphosis, not the fat tissue about the body organs.

The first thoracic mass gets its air supply from the branch of the main trachea that also sends a branch to the apex of the diamond, a branch to the leg, and one to the wing-bud. Apparently the second thoracic fat body receives its trachea from the same source.

From the tracheal branches arising from the main longitudinal tracheal trunk near the spiracular tracheæ in the second to sixth abdominal segments, and which supply the alimentary tract, branches that supply the lobes of the largest fat body originate. The tracheæ from near the second and third spiracles apparently each supply a lobe of the fat body. The tracheæ arising near the fourth, fifth and sixth spiracles send branches into the lobes on each side of them, one forward, and one backward.

The supply to the fat lobe in the seventh segment is apparently a single branch from the trachea to the alimentary tract. The fat body in the eighth segment receives a branch from the tracheæ that run to the digestive system from each side of the body.

To reach the alimentary tract the tracheæ from the spiracles in the second to eighth segments cross the fat bodies dorsally.

Silk Glands

The tracheæ to the silk glands are small branches from the tracheæ supplying the fat bodies and alimentary tract. I only found them springing from the tracheæ in the second and third segments of the abdomen. (Fig. 30).

Malpighian Tubules

Two malpighian tabules on each side extend forward along each side of the alimentary tract from the caudal part of the body to opposite the fourth abdominal spiracle, where they turn and run backward. In the sixth, seventh and eighth abdominal segments, but mostly in the last two, the tubules become very convoluted and intertwine, and their individual characters are lost in the tangle.

Although carefully sought, no tracheal connections with the Malpighian tubules were found, except in the seventh abdominal segment. Here small branches arising from the trachea supplying the fat bodies and alimentary tract were traced to the walls of the Malpighian tubes. (Fig. 30). Figure 31 is a sketch of a branch broken from the supplying trachea to the alimentary tract which showed very plainly the small tracheal branches to a urinary tube.

Circulatory System

The circulatory system consists of a delicate tube in the dorsal part of the body. This is supplied by the ends of the large branches of tracheæ that also supply the dorsal muscles and the fat lying between them and the body wall. The tracheal endings in the circulatory organ are very fine, not numerous, and somewhat difficult to see.

Near the eighth abdominal spiracle several of the branches break up into a great number of very fine tracheæ (Fig. 32). These fine tracheæ lie in, or on, a membrane. They are not connected with the alimentary tract, except incidentally, for removal of the tract leaves most of them undisturbed. Such structures do not occur in the branchings from any other spiracle. That they have anything

to do with the circulatory system is a question. But on the suggestion of Prof. C. T. Brues that they may aerate the blood, I tentatively place them in the group of tracheæ to the circulatory system.

Reproductive System

The gonads are two whitish kidney-shaped bodies lying on each side, adjacent to the heart, in the fifth abdominal segment. They resemble, somewhat, the adipose tissue in which they are imbedded.

In the fifth abdominal segment the tracheæ, which in the other abdominal segments supply the dorsal muscles, the heart, etc., send two branches to the reproductive organs. There is a branch to the muscles, etc., then a branch to the gonad, another branch to the muscles, etc., followed by another branch to the gonad, and another branch to the muscles, etc. It is a fan-like arrangement, with the first, third, and fifth branches to the muscles, fat tissue and circulatory organ, and the second and fourth branches to the gonads.

The tracheæ to the gonads divide into several branches, just as they reach the organs, and branches are sent to various parts of the reproductive organs. (Fig. 33).

Tracheæ of the Muscles

The muscles lying between the longitudinal tracheæ and the mid ventral line receive their air from branches from the transverse tracheæ, and also from those tracheæ of uneven number that lie adjacent to the origin and insertion of the muscles at the edges of the segments.

The muscles lying between the longitudinal tracheæ and the heart receive the principal branches of those branches that end in the heart.

Figures 14 and 15 show the distribution of tracheæ 2 and 3 with their branches to the muscles and illustrate the muscular supply.

Fat Tissue

The fat tissue surrounding the organs, not the fat bodies, receives its air supply from small branches of the tracheæ to the organs. Figure 22 shows tracheæ to fat tissue about the central nervous system.

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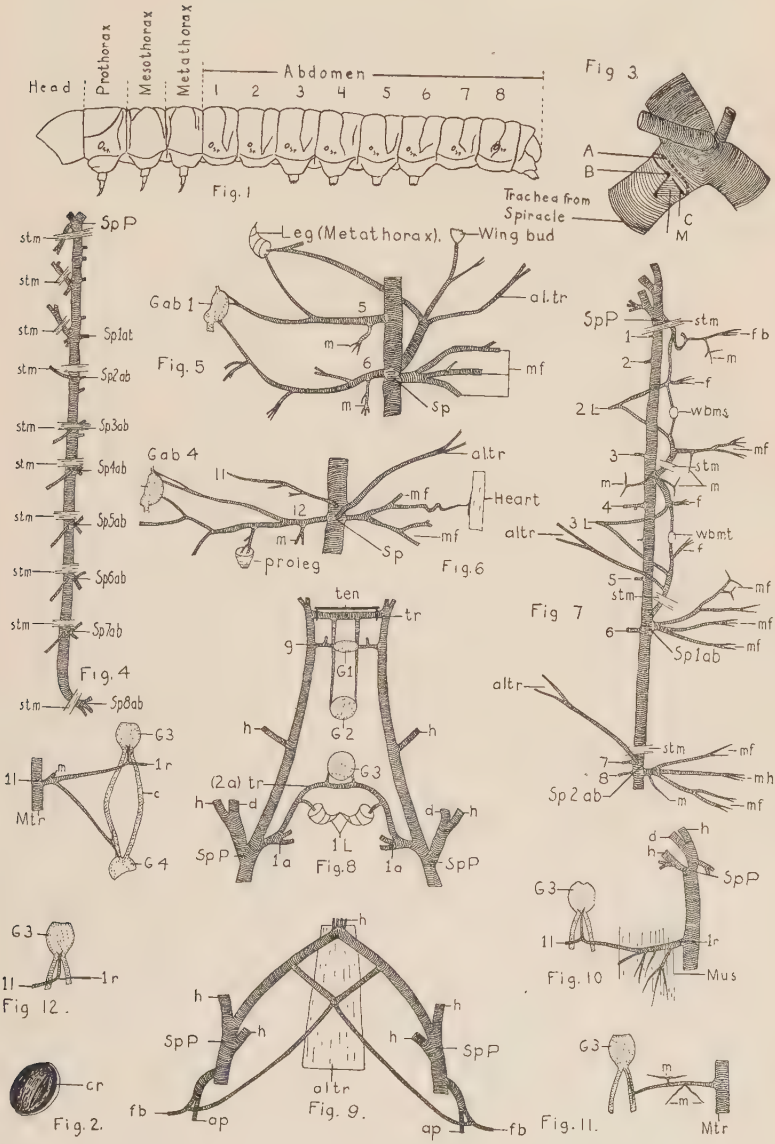

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Description of Plates

Plate I

Fig. 1. Sketch showing positions of spiracles.

Fig. 2. Prothoracic spiracles viewed so that interior can be seen.

Fig. 3. Trachea from spiracle with tracheal closing apparatus.

Fig. 4. Main longitudinal trachea showing positions of sterno-tergal muscles.

Fig. 5. Tracheæ arising from first abdominal spiracle.

Fig. 6. Tracheæ arising from fourth abdominal spiracle.

Fig. 7. Distribution of tracheæ between prothoracic and second abdominal spiracles.

Fig. 8. Transverse trachea in head, and ventral transverse trachea in prothorax.

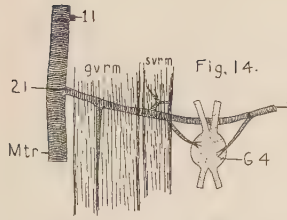
Fig. 9. Dorsal transverse tracheæ between prothoracic spiracles: The Diamond.

Figs. 10, 11, 12, 13. Trachea 1, and some of its variations.

Plate II

Fig. 14. Transverse trachea 2.

Fig. 15. Trachea 3, showing relation to ganglion and muscles.



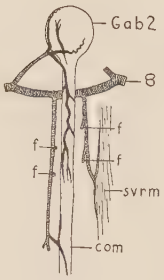


Fig. 22

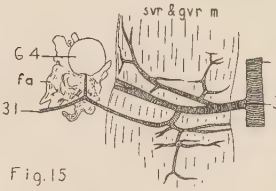


Fig. 15

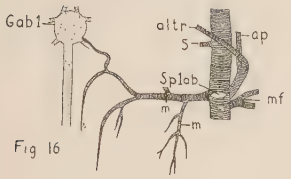


Fig 16

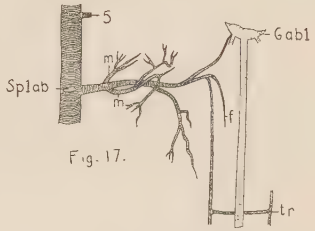


Fig. 17.

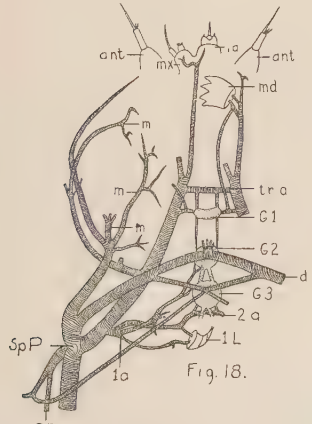


Fig. 18.

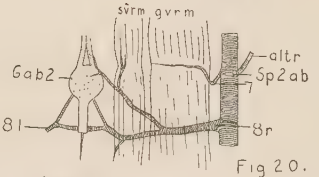
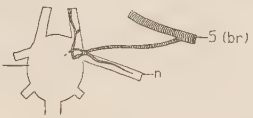
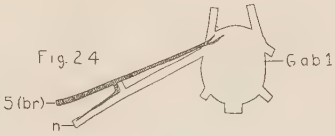


Fig 20.

Fig 23





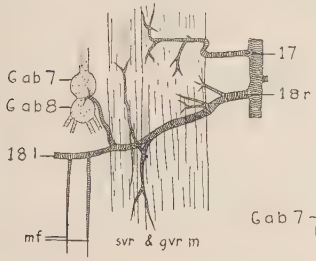


Fig 21

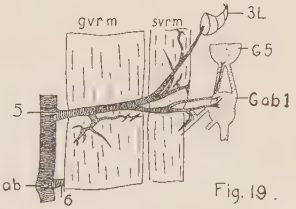


Fig. 19.

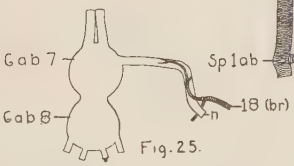


Fig. 25.

Crowell-Tracheal System of *Pyrausta nubilialis.*

Fig. 16. Trachea 6.

Fig. 17. Trachea 6, showing a transverse connection.

Fig. 18. Tracheæ arising from prothoracic spiracle.

Fig. 19. Trachea 5.

Fig. 20. Tracheal supply to second abdominal ganglion.

Fig. 21. Tracheæ to seventh and eighth abdominal ganglion.

Fig. 22. Tracheæ to neural commissures.

Figs. 23, 24, 25. Tracheal supply to nerves.

Plate III

Fig. 26. Tracheæ to thoracic appendages.

Fig. 27. Trachea to proleg of third abdominal segment.

Fig. 28. Trachea to anal proleg.

Fig. 29. Trachea to alimentary tract.

Fig. 30. Tracheæ to fat bodies, silk gland, and Malpighian tubules.

Fig. 31. Detail of tracheal supply to a Malpighian tubule.

Fig. 32. Showing fine tracheæ, arising near eighth abdominal spiracle, and placed tentatively with tracheæ to circulatory system.

Fig. 33. Tracheæ to the gonads.

Abbreviations Used on Figures

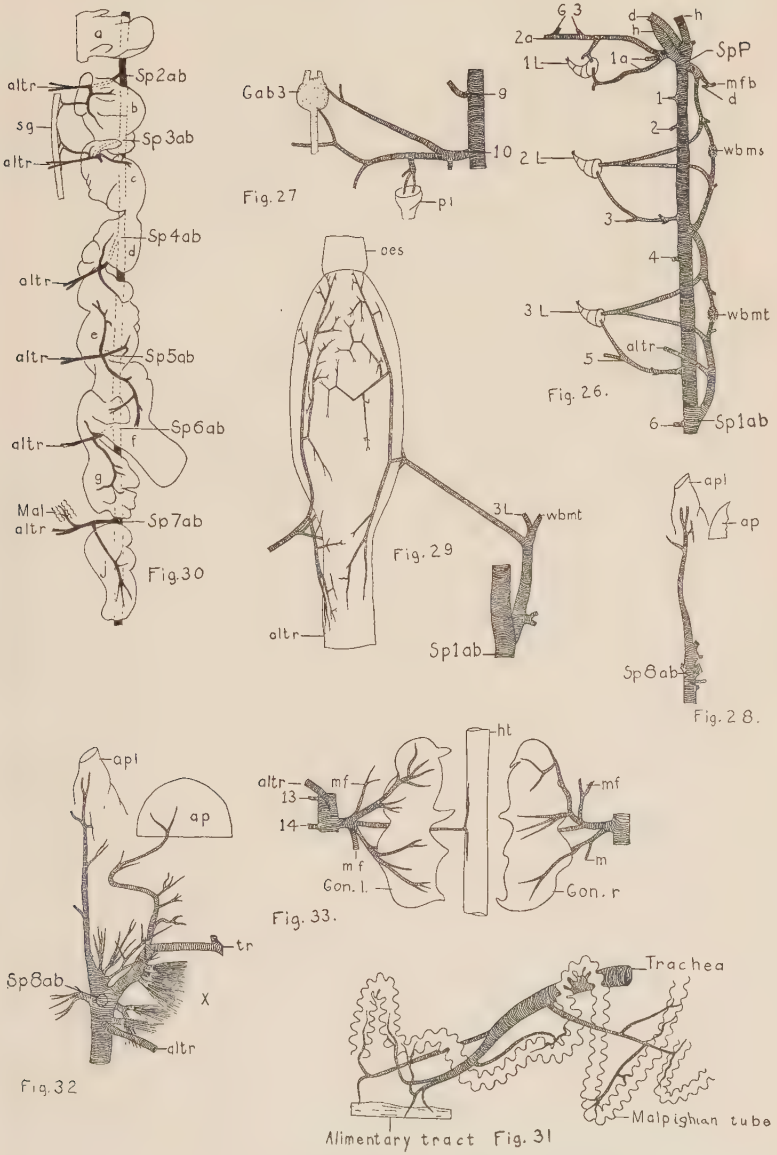
A. closing bow of tracheal closing apparatus.

a. fat body in posterior part of thorax or in first abdominal segment.

altr. alimentary tract, or tracheæ to alimentary tract.

ant. antenna.

ap. tracheæ to appendages.



Crowell-Tracheal System of *Pyrausta nubilalis*.

ap. (Figs. 28 and 32) anal plate.

apl. anal proleg.

1a, 2a. Tracheæ 1a and 2a.

B. Closing lever of tracheal closing apparatus.

(br.) Branch. (Number preceding indicates from which trachea.)

bg. (Fig. 30). Large fat body in 2nd to 7th abdominal segments.

C. Closing band of tracheal closing apparatus.

c. neural commisure.

com. commissure.

cr. chitinous ring.

d. trachea to diamond.

f. tracheæ to fat tissue.

fa. fat tissue.

fb. tracheæ to fat bodies.

g. trachea to supraœsophageal ganglion.

G1. supraœsophageal ganglion.

G2. subœsophageal ganglion.

G3. prothoracic ganglion.

G4. mesothoracic ganglion.

G5. metathoracic ganglion.

Gab. abdominal ganglion. Number attached indicates abdominal segment to which ganglion belongs.

Gon. gonad (l) left; (r) right.

gvrm. great ventro-recti muscle.

h. trachea to head.

ht. heart.

j. fat body in 7th abdominal segment.

L. leg, or trachea to leg; 1, prothoracic, 2, mesothoracic, 3, metathoracic.

la. labium.

M. muscle of tracheal closing apparatus.

m. tracheæ to muscles.

Mal. Malpighian tubule.

md. mandible.
mf. tracheæ to muscles and fat tissue.
mfb. tracheæ to muscles and fat body.
mh. tracheæ to muscles and heart.
Mtr. main longitudinal trachea.
Mus. muscle layer.
mx. maxilla.
n. nerve.
oes. œsophagus.
pl. proleg.
Sp. Position of spiracle. SpP., prothoracic, Sp. 1 ab. to Sp. 8 ab., abdominal spiracles. Numbers indicate segments.
Strm. Sterno tergal muscle.
svrm. small ventro-recti muscle.
ten. tentovium.
tr. transverse trachea.
wbms. mesothoracic wing-bud.
wbmt. metathoracic wing-bud.
1-18. Tracheæ of such numbers.

DESCRIPTIONS OF FIVE NEW SPECIES OF VESPOID WASPS (HYMENOPTERA)

By Raymond Roberts

University of Nebraska, Lincoln, Nebr.

While working on a taxonomic study of the superfamily Vespoidea, the writer has discovered a number of species that are new to science. Following are descriptions of, and comments on five new forms, the type specimens of all of which are in the collection of the University of Nebraska. Acknowledgment is made of the assistance of Professor Myron H. Swenk in the progress of this work and for criticisms in the preparation of this paper.

Paratiphia magna n. sp.

♀. Length 13 mm. Robust. Black, covered with yellowish pubescence. Face below the antennæ wide, transverse at the apex, with a distinct frontal ridge running completely across between the eyes. Clypeus and mandibles red, the mandibles black on their apices. Antennæ black. Head roughened on the vertex, but only slightly reticulated. Punctures large, dense on the lower half of the front, sparse on the upper half. Puncturation of the dorsal surfaces of the pronotum sparse, more dense on the sides, the punctures becoming quite dense on the pleural surfaces of the pronotum, which are reticulated but not striated. A broad impunctate band on the posterior border of the pronotum extending to the tegulæ at the sides. Mesonotum, scutellum and metanotum sparsely punctate on a median area. Wings hyaline, the stigma and first nervure black, the remaining nervures rufous. Tegulæ red. Legs deep reddish, the tibiæ of the mesothoracic and metathoracic legs flat on their outer

surfaces and coarsely spined. Propodeum coarsely striated on the entire pleural surfaces. Dorsal surface of the propodeum with a triangular area, the entire area raised and not bearing a central keel. Abdominal segments 2 to 5 bordered with a fringe of coarse golden hairs. Pygidium finely, densely, rugose papillose on the entire apical half.

Holotype.—Pocatello, Idaho, "73", ♀.

This species agrees quite closely with the description of *P. robusta* Cameron, but differs in the puncturation, being more sparsely punctured on the pronotum and on the pleural surfaces of the entire thorax. There is a broad impunctate area in the center of the mesonotum extending back to the apex of the scutellum, as in *P. robusta,* but there is no impunctate lateral border. The pleural surfaces of the thorax are reticulated but not striated. The wing veins of *P. robusta* are described as being entirely black while those of *P. magna* are rufous. Cameron states that the pygidium of *P. robusta* is smooth, but the writer has not seen a species of *Paratiphia* in which the female has a smooth pygidium.

Sapyga interrupta n. sp.

♀. Length 13 mm. Black. A line extending from the middle of the inner orbits of the eyes upward to and practically filling the emarginations, a short line on the cheeks behind the eyes, an interrupted band on the anterior edge of the prothorax, a spot on the upper part of the mesopleura, two small dots on the metanotum, an interrupted dorsal band on abdominal segments 2, 3, 4 and 5 and a dorsal spot on abdominal segment 6, yellow. Two small ventral spots on abdominal segment 2 and a ventral band on the following segments, interrupted on 4, yellow. Mandibles black. Antennæ black above, rufous beneath, except on the first three and last five segments. Antennæ set into deep frontal grooves. Front elevated, bearing a distinct transverse ridge slightly above its junction with the clypeus, below which it is constricted to make the clypeus narrowly joined to the front. This constricted frontal area is flat

and depressed on either side of a median ridge extending from the transverse frontal ridge to the clypeus, the two ridges forming a rough T. This flat, depressed, frontal area bears three transverse rows of punctures. Legs black to tips of femora, except the front legs which have a long yellow femoral stripe beneath, extending over half of the length of the femora. Middle and hind tibiæ entirely yellow, fore tibiæ marked with black. Tarsi rufous, darker toward the apices. Wings dusky violaceous, darker on the anterior edge of the front wing.

Holotype.—Pikes Peak, Colorado, July 20, 1906, 10,000 feet elevation (L. Bruner), ♀.

Sapyga interrupta most closely agrees with the characterization of *Sapyga americana* Cresson, as given by him in his key to the North American Species of *Sapyga* (Trans. Amer. Ent. Soc., viii, p. xx). It differs from that species, however, in having the clypeus immaculate. The writer has not had the opportunity of examining specimens of *Sapyga americana*, which species Cresson described from a specimen from New York State, but *Sapyga interrupta* differs from all specimens that he has identified, except the following, in having medially interrupted (not complete) yellow bands on dorsal abdominal segments 2 to 5. The first dorsal abdominal segment is unmarked, while segment 6 bears a complete, transverse, broad yellow band. The ventral surface of the abdomen also bears yellow markings on each segment except the first.

Sapyga russellensis n. sp.

♀. Length 10 mm. Black. A small spot on each side of the clypeus, a line extending from the middle of the inner orbits of the eyes upward and practically filling the emarginations, a small dorsal spot on each side of abdominal segment 2, with dorsal bands on segments 3 to 6, narrowly interrupted on 3 and 4, more widely interrupted on 5, yellow. The clypeus joined to the front a little below the frontal ridge, there being but a single transverse row of

large punctures on the constricted, flat, depressed frontal area below the frontal ridge and between it and the junction of the front and clypeus. A distinct ridge extends from the frontal ridge to the attachment of the clypeus, the two ridges forming a rough T. All legs, except a short stripe on the fore femora, black to the tibiæ. Tibiæ black beneath, yellow above. Tarsi yellow at the bases, almost black at the apices. Wings hyaline, somewhat cloudy in the marginal cell. Stigma rufous, nervures black. Antennæ black on bases and apices, rufous in the center.

Holotype.—Russel, Colorado, June 25, 1907 (L. Bruner), ♀.

Sapyga russellensis is related to *Sapyga emarginata* Cresson, but lacks the emargination of the second dorsal abdominal segment. The clypeus bears a small dot on each side near the superior angles instead of a crescent-shaped spot. *Sapyga russellensis* can easily be separated from *Sapyga interrupta* by its being considerably smaller, having the bands of dorsal abdominal segment 2 reduced to mere dots, and the presence of black stripes on the tibiæ. It can also be easily indentified by the shorter, less punctured constricted area of the front.

Eusapyga intermedia n. sp.

♀. Length 10.5 mm. Black. Mandibles except apices, apical three-fourths of the clypeus, an inverted T-shaped mark on the front above the clypeus, the inner and hind orbits of the eyes to the tops of the eyes (leaving only the tops of the eyes black), a spot on each side of the head on top, a broken anterior and complete posterior collar on the pronotum, spots on the scutellum and metanotum, a large part of the mesopleura and propodeum, and wide bands on all dorsal abdominal segments near the posterior margin and on all but the first ventral abdominal segment, yellow. Antennæ red. The clypeus joined broadly to the front and with no transverse frontal ridge present, in which characters it differs from the species of *Sapyga*. Legs with coxæ and trochanters entirely black, the hind femora black

except an anterior apical spot, the middle femora with the anterior side and the anterior femora with the posterior side, yellow. Middle and hind tibiæ marked on the inner side with black, the anterior ones entirely yellow. Tarsi rufous, yellow at bases. Head with the raised spots smaller and the ocelli larger than in other species of the genus which the writer has studied, the spots being slightly larger than the ocelli. Wings clouded, stigma rufous, nervures black.

Holotype.—Auburn, California, August 10, 1918 (L. Bruner), ♀.

This species may easily be distinguished from all others described up to the present time by having the raised impunctate spots on the front small, and by the larger size of the ocelli, they being, in this species, about equal in size to the raised impunctate spots.

Myrmosa bradleyi n. sp.

♂. Length 11 mm. Black, clothed with black pubescence. Palpi black, covered with short white pubescence. Mandibles black with a slight reddish tinge in the center, with three teeth, the inner one of which is very short, the second one extending two-thirds of the distance from the first to the tip of the third. Both of the first two teeth are weak, the third tooth is strong. Pubescence on the mandibles long, light colored toward the tips. Scape of antennæ pubescent, bearing a number of long black hairs, the pedicel about one-fourth as long as the first segment of the flagellum, the flagellar segments subequal in length, the apical segments becoming slightly longer. Clypeus flat. A frontal ridge extending forward between the antennæ and connecting with the clypeus. Head densely punctate with large, shallow punctures. Punctures on prothorax, scutellum and metanotum similar to those on the head. There are two subparallel lines on the mesonotum and a deep groove at the base of the scutellum. Dorsal surface of the propodeum with a longitudinal groove crossed by a transverse ridge at about two-fifths of the distance from the base, and separating the dorsal from the posterior sur-

face of the propodeum. Punctures on the propodeum smaller but continuing in abundance. Wings clouded, stigma and nervures black. First segment of the abdomen with a recurved hook, segment 2 with a minute hook at the base. Pygidium grooved above on the apical half.

Holotype.—Sacramento, California, August 25, 1916 (L. Bruner), ♂.

Dr. J. Chester Bradley mentioned this species, of which he had a broken specimen, in a paper on the North American Myrmosidae (Trans. Amer. Ent. Soc., xliii, p. 251). He did not name and describe the species, due to the fact that the head was lacking on his specimen.

Myrmosa bradleyi may be easily separated from *Myrmosa unicolor* Say by the difference in size (*bradleyi* 11 mm., *unicolor* 8 mm.), in the much darker wing color of *bradleyi,* and in the difference in the coloration of the pubescence.

SOME ADDITIONAL REMARKS ON THE MASARID WASPS (HYMENOPTERA)

By J. Bequaert

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While my study of the Masaridinæ was going through the press for the June 1929 issue of "Psyche", two important papers have been published dealing with these insects. It seems worthwhile to consider in how far the new information they present agrees with the conclusions I had reached.

A. v. Schulthess' "Contribution to the Knowledge of African Masaridæ" (May 1929, Ann. Mag. Nat. Hist., (10) III, pp. 498-511) contains descriptions of ten new species and one new genus. While it confirms what I had to say about the possibilities of future discoveries in this group, it does not call for any change in the map I gave of the general distribution of these wasps. *Masariella* (?) *testaceopicta* v. Schulthess is, I take it, the undescribed species of *Jugurtia*, from Northern Nigeria, which I mentioned in my paper.

Three of v. Schulthess' new species are placed doubtfully in *Masariella*, one of them being from North Africa, one from Northern Nigeria, and the third from South Africa. In how far these species are strictly congeneric with the genotype, *M. alfkeni* (R. du Buysson), is impossible to decide, since the mouth-parts are not described. While v. Schulthess rightly doubts that the relative development of the scutellum and postscutellum is sufficient to distinguish between *Masaris* and *Masariella*, his statement that "the most important criterion remains the number of the joints of the maxillary palpi (two in *Masariella*, four in *Masaris*)," must be due to an oversight. Bradley, who has made the most careful study of the mouth-parts of the Masari-

dinæ, says that in *Masaris* the maxillary palpus is "reduced to a single segment represented by a mere tubercle". He was unable to make out that of *Masariella,* but writes merely that they are "said by Brauns to be two-segmented." It will be noted that the difference is very slight indeed, and, Bradley's opinion notwithstanding, I greatly doubt its value as a generic character. In my recent paper I provisionally placed all the South African species in *Masariella* and those from the Mediterranean Subregion in *Masaris*; but it remains to be shown whether this purely geographical segregation is supported by a consistent difference in the mouth-parts or by other valid generic characters. As for the species from Northern Nigeria doubtfully placed in *Masariella* by v. Schulthess, a careful study of the antennal characters will have to decide whether it is not rather a *Jugurtia* (of which one species is known from Gambia). The shape of the clypeus I can hardly regard as of generic value.

It may be noted that v. Schulthess now expressly synonymizes his genus *Ceramiellus* (1922) with *Masariella,* a course which I had followed in my paper.

The six new species of *Quartinia,* described by v. Schulthess, are all from South Africa and bring the total number of species of that genus up to 14 (8 of them South African).

By far the most interesting addition though is the new genus *Quartiniella,* proposed for a new species, *Q. waterstoni,* of the Cape Province, South Africa. This little wasp, 3½ mm. in total length, is unique, not only among the Masaridinæ but among the entire group Diploptera as well, in the reduction of the wing venation. The fore wing has only one closed cubital and one closed discoidal cell. That the single cubital cell corresponds to the true first cubital of the other Diploptera (and not to the combined first and second cubital cells), is reasonably certain from the course of the only recurrent vein which ends a little beyond the apex of the cubital cell (as stated in the text, while the drawing shows it interstitial). Otherwise the genus is said to be closely allied to *Quartinia,* but the mouth-parts are not described.

Celonites rugiceps Bischoff, 1928, Abhandl. Naturwiss. Ver. Bremen, XXVII, 1, p. 86, which was overlooked by me at the time, increases the number of species of *Celonites* of the Mediterranean Subregion to 10.

In discussing the wing venation, I have overlooked one peculiarity of some importance, to which my attention has been called recently in a discussion with Prof. T. D. A. Cockerell. In all the genera of Masaridinæ known to me, the marginal (or radial) cell (2d R1 + R2) of the fore wing is more or less truncate at the apex, its extremity being distinctly removed from the costal margin and generally provided with an appendicular vein. As pointed out by Bradley (1922, Univ. of California Publ. Ent., I, No. 9, p. 376), the Masaridinæ share this peculiarity with the Euparagiinæ and Gayellinæ, while a truncate or appendiculate marginal cell is rather exceptional among the remainder of the Diploptera. I have seen it in certain species of *Zethus, Labus, Ancistrocerus, Odynerus, Pterochilus, Monobia,* and *Montezumia,* where it occurs rather sporadically, but it never seems to be present in the true social wasps of the subfamilies Ropalidiinæ, Polistinæ, Polybiinæ, Vespinæ and Stenogastrinæ.

Although not of absolute value, the shape of the marginal cell may afford some help in tracing the affinities of the fossil insects that have been referred to the Diploptera. Since in fossil insects the venation of the wings is often much better preserved than the other parts, one is fully justified in using them to the utmost. The value of such work, however, depends entirely upon the reliability of venational characters among the living members of the particular group to which the fossil supposedly belongs.

Fossils referred by various authors to the Diploptera have been found in Europe in the Tertiary of Chaumerac, France, in the Prussian amber (probably Lower Oligocene), in the Lower Oligocene of Aix in Provence, in the Oligocene of the Isle of Wight, England, in the Lower Miocene of Rodoboj in Croatia, in the Miocene of Parschlug in Steiermark, and in the Upper Miocene of Oeningen in Baden. In North America all the specimens described thus far as Diploptera have been obtained in the (supposedly) Miocene

shales of Florissant, Colorado. For many of these fossils the characters mentioned in the descriptions are such that their correct placing among the folded-winged wasps is extremely uncertain.

At the Museum of Comparative Zoology of Harvard University I have carefully studied types (or cotypes) of five of the ten species described by Cockerell from Florissant and placed by him in this group.

Of *Palæovespa gillettei* Cockerell (1906, Bull. Mus. Comp. Zool., L, 2, p. 55) I have seen five specimens. They are in such a condition that the true family, subfamily and generic characters used in the Vespidæ (such as the structure of the eyes, clypeus and thorax, and the number of tibial spurs) cannot be made out. In some of the specimens the fore wing appears to be plaited and, where details of the venation can be traced, they agree perhaps better with those of certain species of *Vespa* than with those of any other genus of living Hymenoptera. The marginal cell is decidedly pointed at the apex, which lies close to the costal margin; the first discoidal cell is much longer than the submedian; the basal vein joins the subcosta a fair distance from the broad stigma (about as in the living *Vespa carolina* Linnæus; but this feature of the wing varies considerably within the genus *Vespa*) ; the two recurrent veins enter the second cubital cell rather farther apart than is usual in *Vespa* (although *V. carolina* differs less in this respect from many *Polistes* than most other species of the genus). The hind wing is not visible in any of the specimens. None of the characters indicated above are, however, decisive in tracing the probable affinities of *Palæovespa.* If one examines an extensive collection of *Polistes* and *Vespa,* he soon realizes the futility of attempting to define these genera upon the venation of the fore wing. As a matter of fact, the fore wing of *Vespa carolina* can well be matched in the genus *Polistes,* while it differs in several important particulars from that of certain other species of *Vespa* (*V. crabro* Linnæus, for example). Nor can the possibility be wholly eliminated that *Palæovespa* might be rather related to the subfamily Polybiinæ, which contains in the living fauna several genera with a broad (not stalk-

like) first abdominal segment and a venation very similar to that of the fossils here under discussion. To judge from the specimens I have seen, at any rate, I can only conclude that *Palæovespa gillettei* is probably a diplopterous wasp and that it most likely belongs in one of the subfamilies of social genera. I have also examined a specimen of *P. florissantia* Cockerell and of *P. scudderi* Cockerell, both very poorly preserved.

The one specimen I have seen of *Odynerus præsepultus* Cockerell (1906, Bull. Mus. Comp. Zool., L, 2, p. 57) is not sufficiently well preserved to allow of its being placed without reservations among the Diploptera. So far as I can make out, the first discoidal cell is not longer than the submedian and there is no clear evidence that the wings were plaited. This fossil might equally well be a fossorial wasp.

I feel quite positive, on the other hand, that *Odynerus palæophilus* Cockerell (1906, *loc. cit.*, p. 56) is not one of the Diploptera. The triangular shape of the high marginal cell and the short first discoidal cell would be a unique combination in that group, while it reminds one strongly of some of the parasitic Hymenoptera. Professor Brues, to whom I have shown this fossil, shares my opinion, and has suggested that it might be related to the Aulacidæ. The wing, it is true, appears to be plaited, but one cannot be sure that this is not due to one of the hazards of fossilization. Moreover, the longitudinal plaiting of the fore wing is not in itself sufficient to place a hymenopterous insect in the Diploptera, as this character occasionally occurs in other groups (Leucospinæ, Gasteruptionidæ, *Galesus*). I have recently taken in Yucatan one of the Psammocharidæ in which the fore wings are distinctly folded longitudinally when at rest.

From the evidence at hand, it is probably safe to conclude that the Diploptera as a group had become differentiated from the other Aculeates before or at the beginning of Miocene times. Cockerell's statement, however, that "the indications are that we must go to the Eocene or even to the Cretaceous, to find the beginning of most of the modern genera of wasps" (1910, Schrift. Phys.-Oekon. Ges. Königsberg, L, p. 1), seems to the writer hardly warranted by the facts.

C. H. Hicks' paper entitled "*Pseudomasaris edwardsii* Cresson, another pollen-provisioning wasp, with further notes on *P. vespoides* (Cresson)" (1929, Canad. Entom., LXI, pp. 121-125) is an extremely valuable contribution to our scant knowledge of masarid biology. The author was fortunate in discovering in California the nests of *P. edwardsii*: they are built of clay and attached to rocks, often filling depressions in them, the number of cells per nest varying from one to ten. Pollen masses were found stored in the cells of some of the nests. Hicks also bred a number of parasites from these nests: a mutillid of the genus *Photopsis*, a chrysid (*Chrysis densa* Cresson), and some chalcids which may have been hyperparasites. According to Timberlake, *P. edwardsii* is common at Riverside, California, during May when it visits the flowers of *Phacelia*.

The same paper contains an interesting observation of the mating of *P. vespoides*, made in Colorado on May 29, 1927. "A male, after sipping nectar from the flowers or going for a short flight, had a habit of returning to a rock close to the ground and resting on its surface in the sun. Before alighting he would hover above the spot, then alight and remain with wings outstretched, nearly but not quite at right angles to his body. At 11.45 A. M. this male was found copulating with a female on a flower of *Pentstemon acuminatus*. The female was in position for obtaining nectar; the male upon her with his antennæ bent forward and gently tapping her with them on the front of her thorax. Her fore legs were folded, her wings lightly to the side and her abdomen somewhat elevated. Soon there was considerable buzzing. It could be seen that the two were in copula and after 15 seconds of intense buzzing, both flew away. The female soon returned to collect while the male flew again to his rock." Females and males were sometimes found resting in the corolla of *Pentstemon*, when the weather was cloudy or rainy or in the evening. In Colorado *P. vespoides* visited almost exclusively *Pentstemon acuminatus*, while in California the same species was found on *Pentstemon heterophyllus*.

These observations on *Pseudomasaris* confirm what I have written concerning the anthophilous habits of the Masaridinæ.

NOTES ON THE SYRPHIDAE COLLECTED AT JAFFREY AND MOUNT MONADNOCK, N. H., WITH A DESCRIPTION OF A NEW SPECIES

By Charles W. Johnson
Boston Society of Natural History

My first visits to Jaffrey and Mt. Monadnock, N. H., were made in February and March, 1917. Even with the deep snow covering the beautiful woodland and mountain, one could readily see that this would be an ideal place for collecting. June, 1917, was therefore selected for another two weeks visit. Arriving on the 15th, the flowers of the choke cherry were just opening and for four days I caught hundreds of syrphids and other insects on these blossoms. Later the flowers of a Cornus followed by those of a Viburnum attracted many other species. Among the specimens obtained were about seventy species of Syrphidæ. In 1920 another visit was made, this time covering a period from June 4th to 14th. In the depression back of the old red school house some timber had recently been cut and from the stumps of sugar maple and birch sap was still flowing freely, the fermented sap containing many larvæ from which were bred *Ferdinandea dives* and *Brachyopa perplexa*. The Cornus bushes were mostly dead, probably winter killed by the severe cold of January, 1918. My next visit was in 1923, staying from June 14th to the 23rd. A few rainy days had made the cherry blossoms poor collecting ground but this loss was somewhat made up by the flowers of the raspberry which had grown up on the clearing back of the old red school house, species of Criorhina and Xylota being especially common. My next visit covering a period from May 9th to 21st, 1925, was perhaps the most interesting. To see the various spring species appear one after the other was a very enjoyable experience. An old oak log along the brook near "The Ark" was visited daily from the 14th to the 21st to secure the two species of

Chalcomyia. The last of my June trips was in 1926 from the 5th to the 18th.

It is interesting to note how seasons and conditions change in different years in this fascinating place. I was not able to duplicate the great catch I made in June, 1917, on the flowers of the choke cherry, neither have I been able to find so much sap flowing from stumps as in 1920, nor another oak log frequented by the two species of Chalcomyia. The area covered in collecting extends from the Shattuck Inn to about 1700 feet on Mt. Monadnock and from Mead's Brook to Hadley Brook, an area of about two square miles. A few trips were made to the top of the mountain (3166 ft.) but no additional species were taken, all those on the bare rocks of the summit being probably derived from lower levels. With "The Ark", where I stayed, as a center, I doubt if there is a corresponding area that would produce as many Syrphidæ in the time mentioned. Of the 113 species recorded below, six were new to science. In addition to these a great many other insects were also collected.

List of Species

Microdon ocellaris Curr. June 20, 1923.
M. tristis Loew. June 14-21, 1923.
M. ruficrus Will. June 21, 1923.
Chrysotoxum fasciolatum DeGeer. June 18, 1917.
Chrysogaster nigripes Loew. June 15-25, 1917.
C. pulchella Will. June 18, 1917.
C. pictipennis Loew. June 18, 1917.
Pipiza femoralis Loew. June 18, 1917.
P. nigropilosa Will. May 14, '25, Junt 14, '23.
P. nigrotibiata Curr. *Allotype* June 17, 1917.
P. quadrimaculata Panz. May 12, '25, June 19, '17.
Heringia salax Loew. June 9, 1920.
Cnemodon pisticoides Will. May 16, '25, June 12, '26.
Paragus bicolor Fab. May 16, '25, June 15, '17.
Chilosia (*Chilosia*) *orillænsis* Curr. June 16-18, 1923.
C. (*Cartosyrphus*) *pallipes* Loew. June 8, 1920.
C. (*Cartosyrphus*) *sialia* Shan. May 18, '25, June 10, '26.
C. (*Cartosyrphus*) *slossonæ* Shan. May 16-18, 1925.
C. (*Cartosyrphus*) *tristis* Loew. June 14, 1920.

Chalcomyia ærea Loew. May 14-21, 1925.
C. cyanea Smith. May 16-19, 1925.
Cynorhinella longinasus Shan. Holotype June 4, 1920.
Myiolepta nigra Loew. June 11-18, 1917, 1926.
M. varipes Loew. June 18, 1917.
Ferdinandea dives O. S. Bred from larvae in sap oozing from the stumps of maple and birch. Adults emerged June 25 to July 6, 1920.
Baccha cognata Loew. June 19, 1917.
B. fascipennis Wied. June 28, 1917.
Pyrophaena rosarum Fab. June 16, 1923.
Platychirus chætopodus Will. June 7-10, 1920.
P. hyperboreus Stæg. June 15, 1917.
P. peltatus Meig. June 15, 1917.
Melanostoma confusum Curr. May 14, '25, June 11, '20.
M. mellinum Linn. May 18, '25, June 19, '17.
M. obscurum Say. May 9, '25, June 18, '17.
Didea fasciata var. *fuscipes* Loew. June 19, 1917.
Syrphus lapponicus Zett. (*arcuatus* auct.) June 12, 1926.
S. amalopis O. S. June 15-19, 1917.
S. johnsoni Curr. *Type* June 15, another June 18, 1917.
S. latifasciatus Macq. June 27, 1917.
S. laticaudus Curr. May 9-18, '25, June 4-10, '26.
S. nitens Zett. May 17, 1925.
S. perplexus Osburn. June 28, 1917.
S. rectus O. S. June 14-18, 1917-'20.
S. ribesii Linn. May 19- June 21, 1917.
S. ribesii var. *vitifrons* Shan. June 15-19, 1917.
S. torvus O. S. May 19, 1925.
S. venustus Meig. June 4-15, 1917-'20.
Epistrophe arcticus Zett. May 9, 1920.
E. diversipes Macq. June 9-21, 1917-'23.
E. fisheri Walt. June 18-27, 1917.
E. genualis Will. May 9, '20, '25, June 15, '17.
E. mentalis Will. May 12, 1925.
E. oronoensis Metc. May 17, 1925.
E. umbellatorum Fab. June 4, 1920.
E. xanthostomus Will. May 18 '25, June 18, '17.
E. xylotoides John. One male, June 18, 1917.
Doros æqualis Loew. June 14, 1920.

Toxomerus geminatus Say. June 21, 1923.
Sphærophoria menthastri Linn. May 16, '23, June 15, '17.
Spheina campanulata Robt. June 20, '23.
S. flavimana Mall. June 21, 1923.
S. infuscata Loew. June 17 and 18, 1917- '26.
S. keeniana Will. May 19, '25, June 10-18, '17-'26.
S. lobata Loew. June 14-19, 1923.
S. monticola Mall. June 11, 1926.
S. petiolata Coq. June 28, 1917.
S. rufiventris Loew. June 18-25, 1917.
Neoascia distincta Will. May 13-20, 1925.
N. globosa Walk. May 20, 1925.
Rhingia nasica Say. May 17, '23, June 15, '17.
Hammerschmidtia ferruginea Fall. June 25, 1917.
Brachyopa diversa John. *Holotype.* June 18, 1917.
B. flavescens Shan. June 23, 1917.
B. notata O. S. June 9-25, 1917-'25.
B. perplexa Curr. June 9-25, 1920-'23.
Condidea lata Coq. One, June 16, 1926.
Sericomyia chrysotoxoides Macq. June 15-21, 1917.
S. militaris Walk. June 18, 1917.
Eristalis compactus Walk. May 13, '25, June 15, '26.
E. bastardi Macq. May 12, '25, June 4-18, 1917-'26 .
E. dimidiatus Wied. May 20 '25, June 16, '23.
E. arbustorum Linn. May 14, '25, June 19, '17.
E. flavipes Walk. May 19, '25, June 18, '17.
E. saxorum Wied. June 16-21, 1917.
E. transversus Wied. June 8-18, 1917-'26.
E. tenax Linn. June 22-28, 1917.
Tropidia quadrata Say. June 28, 1917.
Helophilus fasciatus Walk. (*similis* auct.) June 15, 1917.
Parhelophilus lætus Loew. June 17, 1917.
P. obsoletus Loew. June 16, 1923.
Lejops lunulatus Meig. May 21, '25, June 18, '23.
L. stipatus Walk. (*conostomus* Will.) June 17, '26.
Mallota cimbiciformis Fall. June 15-25, 1917.
M. cimbiciformis var. *bautias* Walk. June 16-18, '17.
M. posticatus Fab. June 16-22, 1917.
Syritta pipiens Linn. May 19, '25, June 18, '17.
Xylota ejuncida Say. June 13-18, 1917-'26.

Xylota aristata n. sp.

Head bluish black, face shining, with a pollinose spot on each side and white hairs on the cheeks, front slightly roughened and pollinose, narrowly margined with brown above the antennæ, first and second joints of the antennæ dark brown, the third joint light brown, arista white, the base with a slight yellow tinge. Thorax black, slightly roughened and with short blackish pubescence, pleura shining, scutellum black, slightly rugose. Abdomen dark blue, shining, second and third segments margined posteriorly with an opaque black band that extends forward in the middle forming a broad triangle. Legs black with white hairs, posterior femora irregularly thickened with a cluster of spine-like bristles on the underside near the apex, posterior tibia strongly curved, with a prominent apical spur, under side of the tarsal joints with yellowish pubescence. Wings hyaline, base, stigma and veins dark brown, the cross-veins slightly clouded. Halteres light yellow. Length, 7 mm.

One male, Jaffrey, May 18, 1925. Type in the collection of the Boston Society of Natural History. The species is readily recognized by its white aristae.

Xylotomina chalybea Wied. June 16-28, 1917-'23.
X. curvipes var. *satanica* Bigot. June 15, '23.
X. pigra Fab. June 9, 1926.
X. plesia Curr. June 12-22, 1923.
X. vecors O. S. June 15-19, 1917.
Brachypalpus oarus Walk. (*frontosus* Loew). May 16 and 21, '25, June 22, '17.
Criorhina intermedia John. *Holotype.* June 15-18, 1917.
Cynorhina analis Macq. June 8-22, 1917-'23.
C. badia Walk. June 16, 1923.
C. confusa John. June 6-18, 1917-'20.
C. nigra Will. May 16, '25, June 18, 1917.
Somula decora Macq. June 17-28, 1917.
Sphecomyia vittata Wied. June 8-21, 1917'26.
Temnostoma alternans Loew. June 15-21, 1917.
T. balyras Walk. June 16-23, 1917-'23.
T. bombylans Fab. June 21, 1917.

An autumn trip to Jaffrey (Oct. 2nd to 16th, 1929) yielded comparatively few insects. Among these, however, were twenty species of Syrphidæ of which the following are not in the above list: *Syrphus wiedemanni* John. *Epistrophe grossulariæ* Meig. and *Toxomerus marginatus* Say.

This region has entomologically speaking, an interesting history from the fact that the earliest collection of insects made in the state were found here. These were collected by the Rev. L. W. Leonard of Dublin, N. H., between 1828 and 1835. The specimens are now in the Harris collection, in the Boston Society of Natural History. In referring to Mr. Leonard's work Dr. T. W. Harris, in a letter to Hentz dated Milton, [Mass.] June 17, 1828, says: "My friend, Mr. Leonard has promised to send me a quantity of duplicates from his parish in Dublin, N. H. near the Grand Monodnoc Mountain. Many among those which I have already received from him are entirely new to me. Mr. Leonard is indefatigable in studying the habits of insects and very successful in raising them from the larvæ. Through him I have ascertained the larvæ of many species in my collection and particularly of the Lepidoptera."

In Hitchcock's Report on the Geology, Botany and Zölogy of Massachusetts, 1835, in the notes, page 601, Dr. Harris says: "I have included in the catalogue some insects which, though found beyond the boundaries of the State, may eventually be detected in Massachusetts. For these, and an immense number of duplicates, I am indebted to my friend the Rev. L. W. Leonard of Dublin, N. H., who has still more increased my obligations to him by his disinterested liberality in sending me even the rare and undescribed insects of which he possessed no duplicates."

In the material collected by Rev. L. W. Leonard are a number of interesting Syrphidæ including the type of *Temmostoma excentricum* Harr., and a specimen of *Criorhina intermedia* John., collected May 1832, which had been sent to Say by Harris in 1833 and given the manuscript name "*Milesia gnava.*" There are also specimens of *Chrysotoxum perplexum* John., *Sphærophoria cylindrica* Say., *Helophilu latifrons* Loew, *Criorhina verbosa* Walk., and *Spilomyia fusca* Loew.

THE PROPER USE OF THE TERMS PARAPSIDES AND PARAPSIDAL FURROWS.[1]

By George S. Tulloch

The terms parapsides and parapsidal furrows are very frequently misapplied by morphologists and systematists working with Hymenoptera. An examination of the literature reveals the fact that the term parapsidal furrows has been used to designate either of two pairs of longitudinal furrows that may be present on the mesonotum of certain Hymenoptera, viz., certain Xiphydriids, Ampulicids, Formicids (*pf* and *no* of Figs. 1, 2, 4, and 5). Likewise, the term parapsides has been used to designate the lateral regions delimited by either pair of the so-called parapsidal furrows (*pa* and *sc* of Figs. 1, 2, 4, and 5, II of Fig. 3). Since it is quite obvious that two distinct pairs of furrows or two distinct sets of regions cannot have the same terms applied to them, it may be of interest to persons working with Hymenoptera to have the correct application of the terms re-established as intended by their author. Moreover, as these characters are diagnostic and widely used in the classification of Hymenoptera, it is quite essential that the correct terms should be brought to the attention of present workers so that their usage may be stabilized and unnecessary confusion eliminated in future literature.

The term parapsides was first used by Macleay, 1830, (page 148, footnote 1) to designate certain lateral regions occurring on the mesonotum of *Polistes billardieri* Fabr.[2] Naturally the furrows delimiting these regions are the parapsidal furrows although Macleay does not specifically designate these furrows as such. Figure 3 of this paper is

[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 323.

[2] Dalla Torre, 1904, considers *P. billardieri* Fabr. a variety of *P. crinitus* Felton.

a portion of the mesonotum of *P. billardieri* Fabr. bearing the parapsides and parapsidal furrows taken from Macleay's original figure and is enlarged to twice the size of his figure. In his explanation of the plate he designated the parapsides of the mesonotum with the Roman numeral II. Since it is perfectly clear from his figure as well as from his description (page 148, footnote 1) that he intended the term parapsides to be applied to the lateral regions of the mesonotum delimited by the longitudinal (parapsidal) furrows, it is logical that all homologous regions and furrows in other Hymenoptera should be similarly designated as it

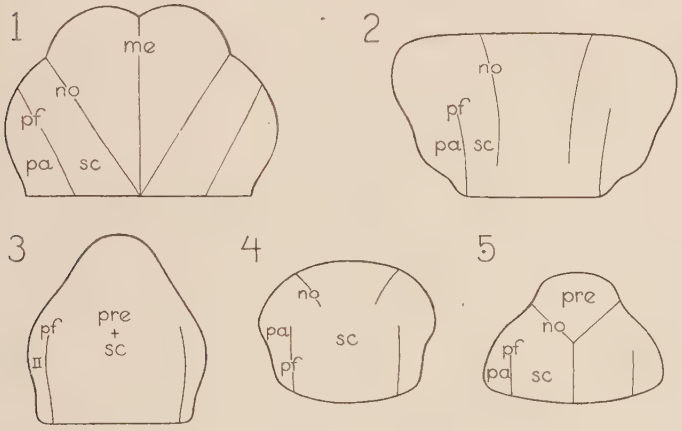

Fig. 1. Portion of the mesonotum of *Xiphydria*.
Fig. 2. Portion of the mesonotum of *Ampulex*.
Fig. 3. Portion of the mesonotum of *Polistes billardieri* Fabr.
Fig. 4. Portion of the mesonotum of *Myopopone castanea maculata* Roger.
Fig. 5. Portion of the mesonotum of *Paraponera clavata* F. Sm.

is one of the important principles of comparative morphology to apply the same term to the homologous anatomical parts in different groups.

If all Hymenoptera had a mesonotal structure similar to that of *P. billardieri* Fabr. the matter would have been much simplified and no confusion would have resulted in the literature. However, in certain Hymenoptera (*Xiphydria, Ampulex, Paraponera,* Figs. 1, 2, and 5) another pair of longitudinal furrows appears extending backward from the ante-

rior margin of the mesonotum and converging more or less in their course. It is these furrows that have been erroneously identified by some workers as parapsidal furrows for years; likewise, the lateral regions delimited by them and the true parapsidal furrows have been erroneously identified as parapsides. Since the correct term which should be applied to these furrows is little known, it may be of interest to review briefly the terms that have been applied to them, and, also to indicate the term which should have priority over the others as determined by its commonly accepted and correct usage in the literature.

Morphologically these furrows which extend backward from the anterior margin of the mesonotum a varying distance and at a varying angle of convergence have been considered to form the lateral limits of the prescutum when they converged sufficiently to fuse into a single median line. They have been correctly referred to as "prescutal sutures" by Crampton, 1926. In such cases as *Paraponera* (Fig. 5) they clearly limit the prescutum, but in many forms like *Ampulex* (Fig. 2) they open out and approximate parallel lines. It is obvious in such cases that the prescutum is not clearly delimited and that it fuses with the scutum to form the general region prescutum plus scutum.[1] Although, as just stated, the failure of these furrows to converge and fuse makes it impossible to determine the posterior lateral limits of the prescutum; their presence, if even of short length extending backward from the anterior margin of the mesonotum, indicates at once the lateral limits of the prescutum in the anterior region. In some forms such as *Polistes* these furrows are absent (Fig. 5) and in a similar case it has been assumed by a recent worker that the prescutum extends laterally to the parapsidal furrows. An examination of the immature pupal stages of *Polistes* reveals the presence of these prescutal sutures which gradually disappear as the chitin hardens before attaining the adult condition. In at least one species of *Polistes*

[1] The writer is cognizant of the fact that when the furrows converge and fuse, Snodgrass, 1926, does not consider the region delimited by them as the prescutum but as a part of the scutum. The writer does not on the basis of the evidence presented accept this view.

the prescutal furrows are present in the adult. In *Pepsis*, a somewhat similar form, the mesonotum is, at first glance, composed of a large central area bounded laterally by the parapsidal furrows. A closer examination of the mesonotal surface reveals the presence of a pair of short indistinct furrows extending backward from the anterior margin. These are the remains of the prescutal furrows and delimit the anterior lateral borders of the prescutum. From the foregoing it is quite evident that the huge, apparently undifferentiated area present in *Polistes* and *Pepsis* is a combination of prescutum plus scutum and in no case does the prescutum extend laterally to the parapsidal furrows.

Mayr, 1861, was the first to mention these furrows which morphologically limit the prescutum in some forms and in his early writings applied to them the indifferent term *"convergirende Furchen."* Later, 1878, he identified them erroneously with the furrows of Macleay calling them *Parapsidenfurchen.* Kokouyew, 1898, designated these furrows as *notauli.* Emery, 1900, noted the misinterpretation of Mayr and designated the central furrows as *Mayrian furrows.* Morley, 1903, used the term *notauli* in the same sense as Kokouyew. Schmeideknecht, 1907, uses the term *notauli* for the central furrows but gives it as a synonym of *Parapsidenfurchen* which is obviously incorrect. It may be seen from this brief sketch of the terms applied to these furrows that *convergirende Furchen, notauli,* and *Mayrian furrows* are synonymous. Since the term *notauli* has been used more widely than the other two terms and is perhaps the most appropriate of the three because, by derivation, it means "hollows on the back," present workers who have not already adopted this term to indicate the central furrows should do so and thus aid in avoiding any further confusion in the literature.

Some very clear distinctions between parapsidal furrows and notauli are evident upon an examination of different Hymenoptera. Both pairs of furrows are extremely variable in character, yet the following generalizations may be made. The parapsidal furrows may be present and the notauli absent, or vice versa, and occasionally in some forms both parapsidal furrows and notauli may be absent. In

forms such as *Xiphydria* (Fig. 1) the parapsidal furrows extend from the transcutal suture of the mesoscutum to the anterior margin of the mesonotum. In forms like Paraponera (Fig. 5) they extend only halfway to the anterior margin of the mesonotum. Other gradations may be noted by simply examining other forms which always exhibit the tendency of the furrows to be lost in the anterior region and to be retained in the posterior region of the mesonotum. This would seem to indicate that the parapsidal furrows extend forward from the posterior region of the mesonotum or from the transcutal suture of the mesoscutum a varying distance in different forms. Another feature of the parapsidal furrows is that they usually extend forward parallel to each other (Figs. 4 and 5) or they diverge (Figs. 1 and 2) and rarely, if ever, have their terminal points at a position which is convergent from the assumed starting point at the transcutal suture. In the form of Polistes (Fig. 3) figured in this paper the parapsidal furrows appear to converge though their terminal points are at a position which is divergent from the points of intersection of the parapsidal furrows and the transcutal suture. The distinctive characteristics of notauli are to some degree the converse of the characteristics of parapsidal furrows. In forms like *Paraponera* (Fig. 5) and *Xiphydria* (Fig. 1) they converge backward from the anterior margin of the mesonotum, and fuse to form a median line. In forms like *Ampulex* they extend backward in a course closely approximating parallel lines but do not reach to the transcutal suture of the mesoscutum. In forms such as *Myopopone* (Fig. 4) they extend but a short distance backward and in *Polistes* (Fig. 3) they are absent. From the above facts the following generalizations may be made: notauli apparently extend backward from the anterior margin of the mesonotum a varying distance and at a varying angle of convergence, occasionally approximating parallel lines in their course but rarely, if ever, diverging from their assumed starting points at the anterior margin of the mesonotum.

Occasionally in some forms such as *Xiphydria* (Fig. 1) a median line (*me* of Fig. 1) is present extending longitudinally along the central region of the mesoscutum. The pres-

ence of this median line is of minor significance since it is used in the classification of only one group of Hymenoptera. However, its presence along with the notauli and parapsidal furrows illustrates the complete number of longitudinal lines of furrows that have been observed on the mesonotum of Hymenoptera.

Much of the confusion existing in the literature has resulted from the mistaken impression that the terms parapsidal furrows and notauli are synonymous. From the foregoing discussion it should be clear that this is not the case, since they are two distinct pairs of furrows, each pair so completely localized in position and possessing such distinct characteristics that misidentification should be impossible.

The terms discussed may be defined as follows:

1. Parapsidal furrows—longitudinal furrows extending anteriorly from the posterior region of the mesonotum or from the transcutal suture of the mesoscutum and varying in length and in their course from one approximating parallel lines to one which is strongly divergent but very rarely, if ever, converging from the original point in the posterior region of the mesonotum.

2. Parapsides—(sing. parapsis) lateral regions delimited by the parapsidal furrows and the tegulae.

3. Notauli—(sing. notaulus) longitudinal furrows extending posteriorly from the anterior margin of the mesonotum, varying in length and in angle of convergence, and occasionally approximating parallel lines but rarely, if ever, diverging in their course from the anterior margin of the mesonotum.

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Abbreviations

me. median line.
no. notauli.
pa. parapsides.
pf. parapsidal furrows.
pre. prescutum.
sc. scutum.
ll. parapsides (Macleay's original designation)

Explanation of Text Figure

Figure 1. Portion of the mesonotum of *Xiphydria*.

Figure 2. Portion of the mesonotum of *Ampulex*.

Figure 3. Portion of the mesonotum of *Polistes billardieri* Fabr.

Figure 4. Portion of the mesonotum of *Myopopone castanea maculata* Roger.

Figure 5. Portion of the mesonotum of *Paraponera clavata* F. Sm.

NOTES ON THE HABITS OF AMPHIZOA

By P. J. Darlington, Jr.

Amphizoa is such a curious beetle and is still so rare in collections that it was among my chief *desiderata* on a trip to the Northwest during the summer of 1927, when I was collecting "on shares" for Dr. J. G. Gehring. My introduction to the insect was performed by Dr. E. C. Van Dyke, whom I chanced to meet on Mount Hood, and with this auspicious start a total of about 350 specimens, including all the American species of the genus, was secured in the various localities visited. Horn (Proc. Ent. Soc. Philadelphia 6, 1867, p. 289) has compared the habits of these beetles to those of the Parnidæ, but this proved so misleading in my case that I think some further notes on their collecting are justified.

The three species have mutually similar habits. They occur chiefly in two sorts of places, either in gravel at water level along the banks of streams, or in masses of floating trash which have gathered against obstructions. In the first case they are nearly always at the side of an eddy or at a curve in the stream, or where for some reason the current is throwing up detritus. The collector soon learns to recognize likely spots by the presence of deposits of spruce needles or masses of foam. In favorable places the shores are often so undercut that the beetles must be sought in shallow caves or under overhanging rocks. Good collecting may be found in both swift and comparatively slow brooks, but in the latter the Amphizoa are usually in the rapid stretches.

A few examples of the right sort of place are, perhaps, worth giving. On Mount Hood Dr. Van Dyke and I found *Amphizoa insolens* in trash which had been caught against bushes in a small brook, just where the latter crossed a sand-filled beaver dam. Numerous *A. striata* Van Dyke were collected in similar rafts of trash which had gathered

in a fallen sapling, partly damming a large brook near Duncan, Vicoria Island. In the Olympic Mountains *A. insolens* was common wherever a stream had deposited drift material. The species ranged from just below tree line on the north side of Mount Olympus to near Sol Duc Hot Springs. *A. insolens* and *A. striata* were taken beside eddying pools in a rapid stretch of Tokul Creek, near North Bend Washington, but were absent in the more gently flowing upper part of the same stream. A mass of floating logs and trash driven by the wind into the outlet of Lake Minnewanka, near Banff, Alberta, yielded a good series of *A. lecontei* and a few *A. insolens*.

From all this it will be seen that the species of Amphizoa live in cover where a brook or the current set up by a wind will bring them food, and it is a fair deduction that the insects are in some part scavengers, although I have never seem them feeding. I do not know whether they travel much, but I knocked down a single *lecontei* as it flew over the lake at Banff.

My specimens were all taken between July 4 and August 19, but adults undoubtedly occur through a much longer season. Freshly emerged *A. insolens* were secured near North Bend, Washington, July 30.

By day Amphizoa keeps out of sight, usually buried in gravel or clinging to a stick in a raft of floating trash. It is possible, however, that they are more active at night.

The beetles may be taken easily once their haunts have been discovered. Where they are among rocks or in gravel, the bank is dug out at water level, and raked a little at a time into the brook; where they are in floating material, the later is spread out on the water and beaten with a stick or the flat of the hand. The treatment in either case is to dislodge the beetles and separate them from the cover. When this is done, they swim slowly with their backs breaking the surface, for they cannot dive.

Specimens are frequently found in crevices in floating logs, especially when the latter are surrounded by masses of drift. A few individuals escape by crawling down rocks or log jams into deep water, and these do act like Parnidæ, but the behavior is for the most part much more like that of

certain Hydrophilidæ. Indeed one hydrophilid, *Hydrobius scabrosus Horn,* is often found with Amphizoa, which it evidently imitates in its method of life. The Hydrobius is sometimes found along lake shores, however.

Amphizoa emits an odor which is rather pleasant, at least to the collector, and which Horn compares to that of decaying wood. The beetles also exude a thickish, yellow fluid from the joints, so that they leave a cigarette-like stain on the fingers.

Dr. Van Dyke's classification of our three American species (Pan-Pacific Entomologist 3, 1927, p. 197) is perfectly satisfactory. *D. striata* and *D. lecontei* hardly differ in color, however, as my large and variable series show, and the size difference is slight. The important difference is, of course, in the form of the elytra. It will be interesting to see whether the two species occur together, or whether intermediate forms occupy intermediate regions.

HABITS OF THE STAPHYLINID BEETLE *DIANOUS NITIDULUS*

By P. J. Darlington, Jr.

Dianous nitidulus Lec. is to be found in moss and similar cover along the swift, shady mountain brooks which drain the west side of Mount Moosilauke, near Warren, New Hampshire. All my specimens have been taken early in July. The species may be washed out like its relatives, but possesses a remarkable habit which is likely to take the collector by surprise.

On land the beetles are not particularly active, but they can skim so swiftly over running water that they disappear as if by magic in the changing shadows of the brook surface. I have had great difficulty in observing the "skimming," for I have never succeeded in getting a healthy Dianous into the laboratory, but the only possible explanation of the phenomenon is that the insects fly on the water partly supported by surface tension, as Donacia often does. This explains the fact that they bog down easily and cannot skim when bedraggled. They follow a straight or curving course, never zigzaging, and go several times faster than they can on land, so that their passage sets up a miniature, V-shaped swell. I have never seen a Dianous rise clear of the water as Donacia does, however.

The skimming habit is, of course, an admirable adaptation for a riparian beetle which lives along swift, fluctuating streams. It is shared by certain species of the related genus Stenus, particularly by some of the red-spotted forms which approximate Dianous in choice of habitat, but many Stenus are nearly helpless on a water film. The retiring habits and quick escape of *D. nitidulus* doubtless explain Major Casey's remark (Revision Stenini, page 9) that "When its localities are found, it seems to be numerous, but these are very seldom discovered."

It is barely possible that some habit of this sort, acquired by an adephagous beetle, may have started the evolution of the Gyrinidæ, which are almost certainly not derived from dytiscid stock and whose ancestors very likely never possessed true diving habits.

NEW BOOKS.

Insects, Ticks, Mites and Venomous Animals of Medical and Veterinary Importance, Part I, Medical. By W. S. Patton and A. M. Evans. X+786 pp., 40 pls., 373 figs., 8vo. Croydon, H. R. Grubb.

This large, well illustrated and finely printed volume includes a discussion of insects and other Arthropods in their relations to disease in man. The text is arranged in the form of lectures and laboratory exercises as presented to students in the Liverpool School of Tropical Medicine. The general arrangement of material is strictly adapted to this especial teaching purpose and a considerable amount of space is given up to laboratory directions and the descriptions of demonstration material. Nevertheless, there is a large amount of information which will be of great value to entomologists as well as to medical men, since as a whole the book forms a balanced compendium of medical entomology. The authors state that it is intended to supplant Patton and Cragg's Medical Entomology, published in 1904. C. T. B.

Ants, Bees and Wasps. Sir John Lubbock. Edited and Annotated by J. G. Myers, XIX+377 pp., Kegan Paul, Trench, Trubner & Co., London. E. P. Dutton & Co., New York, 10/6.

This latest edition of Sir John Lubbock's widely known classic is enlarged by a long series of annotations by Dr. Myers. These extend over more than 100 pages and serve to augment, qualify or refute, in the light of more recent knowledge, parts of the original presentation which appeared nearly fifty years ago. C. T. B.

Insect Singers, A Natural History of the Cicadas. By J. G. Myers. XIX+304 pp., 8 pls., and 116 figs. Geo. Routledge & Sons, London. 21/.

The external and internal structure, classification and life history, of the cicadas and their relation to other animals and plants from the major part of Dr. Myer's treatise, but there are also interesting chapters on cicadas in mythology, art and literature, on their psychology and behavior, and an account, with musical transcriptions, of the songs of a number of species. An extensive bibliography and index complete a most interestingly written and valuable account of these remarkable insects. C. T. B.

Insects, Their Structure and Life: A Primer of Entomology. By G. H. Carpenter. X+335 pp., 4 pls., 183 figs. E. P. Dutton & Co., New York, $3.75.

This is a short general account of insects intended as an introduction to entomology. In small compass it gives a very clear account of the anatomy, development, classification and varied habits of insects, viewed with such insight into biological principles that one may recommend it heartily to the amateur, beginning student of entomology or even to the layman who wishes to become familiar with this group of animals. A short, but well chosen list of references will serve to introduce the reader to entomological literature.
C. T. B.

Errata for Vol. 36.

p. 125, line 15, read *"Oribates castanea"*

p. 127, line 17, for form read "formed"

p. 128, line 14, read "it is not"

p. 125-126, for Michæl read "Michael"

p. 168, line 7, for *pallipes* read *"pilipes"*

p. 170, figure 8 is printed with the bottom at the left side of the page.

p. 172, line 35, read "in the insect world"

PSYCHE

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A regular meeting of the Club is held on the second Tuesday of each month (July, August and September excepted) at 7.45 p.m. at the Bussey Institution, Forest Hills, Boston. The Bussey Institution is one block from the Forest Hills station of both the elevated street cars and the N. Y., N. H. & H. R. R. Entomologists visiting Boston are cordially invited to attend.

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